Master of Physics

Second Secondary

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Introduction for studying Physics

1) Area (m^2)

- Area of circle = πr^2
- Area of square = side × side = S^2
- Area of rectangle = length × width
- Area of sphere = $4 \pi r^2$
- Area of cube = 6 × area of face = $6 S^2$

2) Volume (m^3)

- Volume of cube = side × side × side.
- Volume of cuboid = length × width × height.
- Volume of cylinder = base area × height = $\pi r^2 \times h$
- Volume of sphere = $\frac{4}{3} \pi r^3$

3) Circumference (perimeter) (m)

- Circumference of square = 4 × side.
- Circumference of rectangle = 2 (length + width)
- Circumference of circle = $2 \pi r$

4) Dimensional formula (D.F.) [$M^a L^b T^c$]

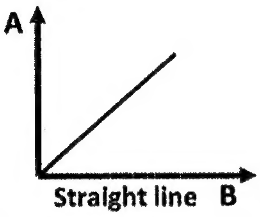
Law	Unit	D.F
1) $V = \frac{\Delta S}{\Delta T}$	ms^{-1}	LT^{-1}
2) a or (g) $= \frac{\Delta V}{\Delta T}$	ms^{-2}	LT^{-2}
3) Force = Ma	$Kg\ ms^{-2} = N$	$M L T^{-2}$
4) Momentum (P_L) = M.v	$Kgms^{-1}$	$M L T^{-1}$
5) Pressure (P) $= \frac{Force}{Area} = \frac{Ma}{Area}$	$\frac{kg.m.sec^{-2}}{m^2} = kg\ m^{-1} sec^{-2}$	$M L^{-1} T^{-2}$
6) Work = force × Displacement = M × a × d	$Kg.m.sec^{-2} m = kgm^2.sec^{-2}$	$M L^2 T^{-2}$
7) Density $= \frac{Mass}{Volume} = \frac{M}{V_{ol}}$		

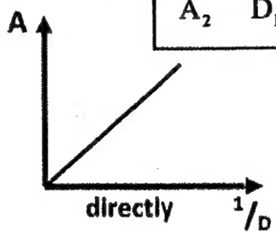
5) Relations : [$A = \frac{BC}{D}$]

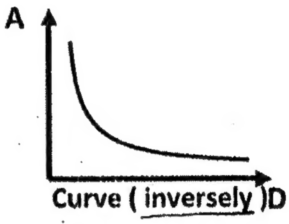
- **A α B at cons. (C) and (D)**
- **A α C at cons. (B) and (D)**
- **A α $\frac{1}{D}$ at cons. (B) and (C)**

$$\frac{A_1}{A_2} = \frac{B_1}{B_2}$$

$$\frac{A_1}{A_2} = \frac{D_2}{D_1}$$







slope = $\frac{A}{B} = \frac{C}{D}$

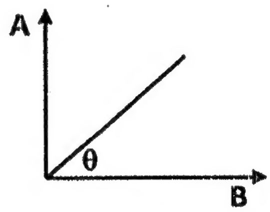
Slope = A ÷ $^1/_D$ = AD = BC

6) Graphs :

- **[A = BC]**
- **Slope**

$$\frac{\Delta y}{\Delta x} = \tan\theta$$

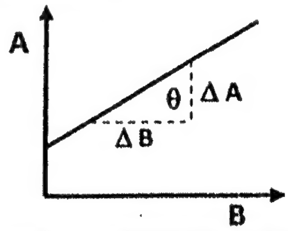
$$= \frac{A}{B} = C$$



- **[A = BC + D]**
- **Slope**

$$\frac{\Delta A}{\Delta B} = C$$

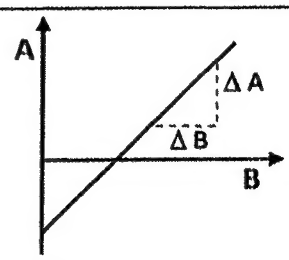
- **The portion which is cut from y axis = D**



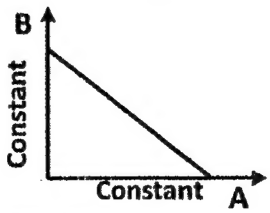
- **[A = BC - D]**
- **Slope**

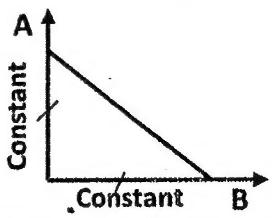
$$\frac{A}{B} = C$$

- **The portion which is cut from y axis = D**



- **[A + B = Constant]**





7) How can you make scale :

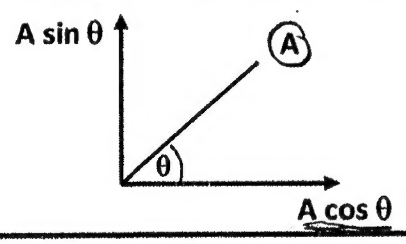
0.1	0.2	0.3	0.4	.... max. no. 2
1	2	3	4	.... max. no. 20
10	20	30	40	.... max. no. 200
100	200	300	400	.... max. no. 2000
2	4	6	8	.... max. no. 40
5	10	15	20	.... divible by 5
0.2	0.4	0.6	0.8	.... max. no. 4
				Odd scale لا يوجد

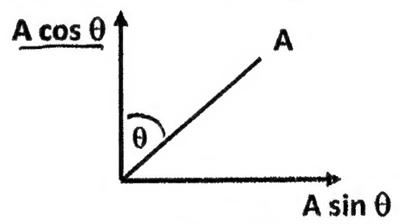
8) Units :

Deci (d)	10^{-1}
Centi (c)	10^{-2}
Milli (m)	10^{-3}
Micro (μ)	10^{-6}
Nano (n)	10^{-9}
Pico (P)	10^{-12}
Femto (F)	10^{-15}
Kilo	10^{3}
Mega	10^{6}
Giga	10^{9}
Tera	10^{12}

	Unit
Small unit $\xrightleftharpoons[10^{+ve}]{10^{-ve}}$ large	
Cm $\xrightleftharpoons[10^{+2}]{10^{-2}}$ m	Length
Cm^2 $\xrightleftharpoons[10^{+4}]{10^{-4}}$ m^2	Area
Cm^3 $\xrightleftharpoons[10^{+6}]{10^{-6}}$ m^3	Volume
$m^3 \xrightarrow{10^3}$ litre $\xrightarrow{10^3} cm^3$	
antgstrom = $\xrightleftharpoons[10^{+10}]{10^{-10}}$ m	
Kg.wt $\xrightarrow[\times (g)]{\times 9.8}$ N	

9) Analyzing of vectors





$\boxed{A^\circ} = 10^{-10}$ m

Angstrom

Chapter (1) : Wave motion

خلل- اضطراب تنتقل

- It is disturbance that propagate and transfer energy along its direction of propagetion .

Tyepe of waves :

Mechanical waves	Electromagnetic waves
• It is a disturbance which need a medium to propagate.	• It is a disturbance which can propagate in space and medium.
• It consists of transverse waves and longitudinal waves .	• It consists of transverse waves only .
• It is produced from the vibration of particles of medium either perpendicular (T.W.) or along (L.W)the direction of propagation.	• It is produced from thevibration of electric and magnetic fields in a direction perpendicular to the wave propagation .
• Water waves – sound waves - waves propagte through string.	• Radio waves -light waves - x-rays - γ rays - T.V - mobile waves .

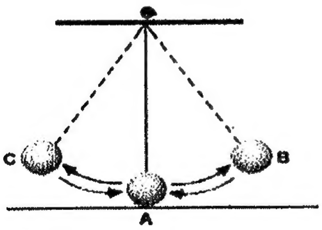
Mechanical waves:

- To produce mechanical waves there must be:
  (1) A source of disturbance(vibrator). [vibrating source]
  (2) Disturbance that can be transferred , from source to the medium
  (3) Medium that carries the disturbance, [vibration]

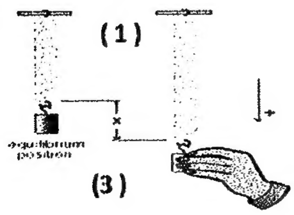
solid, liquid, gas

Examples of vibrating sources :

1- Simple pendulum .
2- Prong of vibrating tuning fork .
3- Vibrating stretched wire .
4- A bob held in spiral spring (yoyo).



(1)



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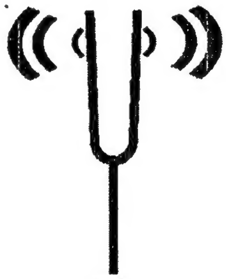

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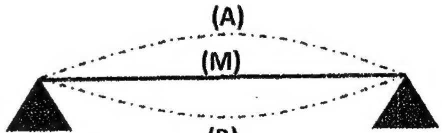


(4)

Definitions to describe vibrational motion:

(1) Displacement (meter):

- It is the distance between the position of the vibrating body at , any instance and its position of rest.

(2) Amplitude (meter) : [A]

- It is the maximum displacement for the vibrating body .
- It is the distance between two points on its path where its velocity at one point is maximum and at the other point is zero.

(3) Complete vibration (Wave form):

- It is prodused when the vibrating body passes by a fixed point on its path two successive times in One direction (it contains 4 amplitudes).

(4) The period (τ) ($\tau = {}^{1}/_{\upsilon}$) (sec = Hz^{-1})

- It is the time of one complete vibration (oscillation) .
- It is the time taken by a vibrating body to pass a fixed point two successive times in the same direction.

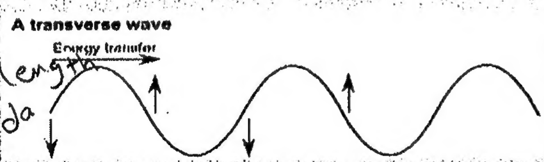
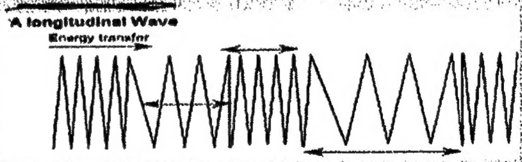
(5) The frequency : (υ) ($\upsilon = {}^{1}/_{\tau}$) [Hz = sec^{-1}] [ν]

- It is the number of complete vibrations (oscillation) in one second.

No. of waves in one second

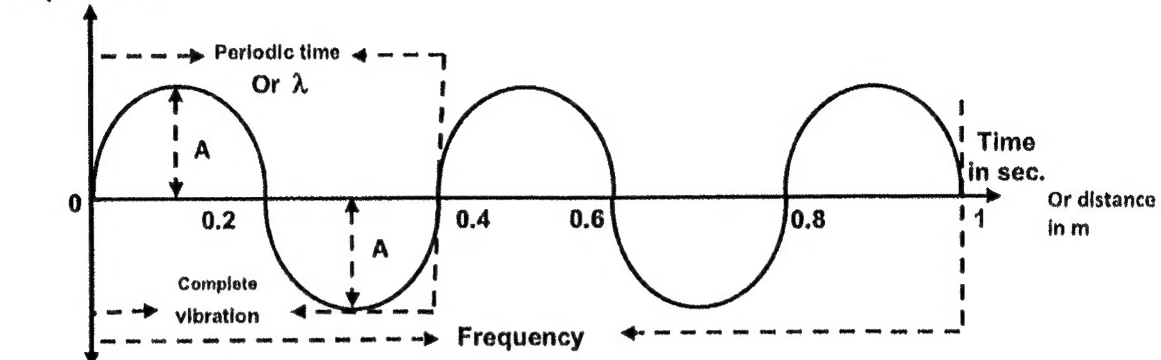
Mechanical waves :

*

Transverse wave	Longitudinal wave
1. "It is the wave motion where particles of the medium vibrate perpendicular to direction of wave propagation"	1. "It is the wave motion where particles of medium vibrate in along the direction of wave propagation" in the direction
2. It consists of crests and troughs.  wave length lampda λ : It is the distance between two successive crests or troughs .	2. It consists of compressions and rarefactions  λ : It is the distance between the centers of two successive compressions or rarefactions .
3. Examples : water waves – wave propagate through a string .	3. Examples : sound waves .

Wave length (λ)

- It is the distance between two successive points having the same phase (same direction and velocity " displacement ")



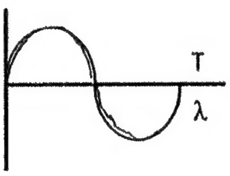
prove that $v = \lambda \cdot \nu$

The relation between (λ , υ, V)

$$V = \frac{x}{t} = \frac{\text{distance}}{\text{time}}$$

$$X = \lambda \quad , \quad t = T$$

$$V = \frac{\lambda}{T} = \lambda \times \frac{1}{T}$$



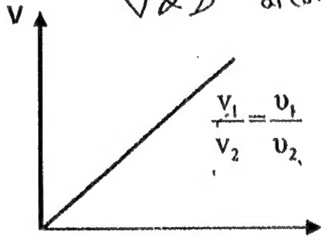
$$\upsilon = \frac{1}{T}$$

$$\boxed{V = \lambda \upsilon}$$

$$\therefore \frac{V_1}{V_2} = \frac{\lambda_1}{\lambda_2} \quad \text{at constant} (\upsilon)$$

$$\therefore \frac{\lambda_1}{\lambda_2} = \frac{\upsilon_2}{\upsilon_1} \quad \text{at constant} (V)$$

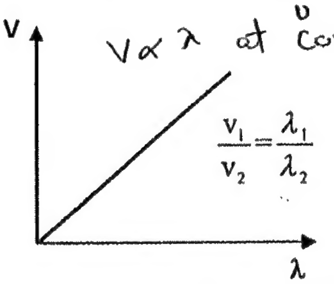
$V \propto \nu$ at const (λ)



$$\frac{V_1}{V_2} = \frac{\upsilon_1}{\upsilon_2}$$

$$\text{Slope} = \frac{V}{\upsilon} = \lambda$$

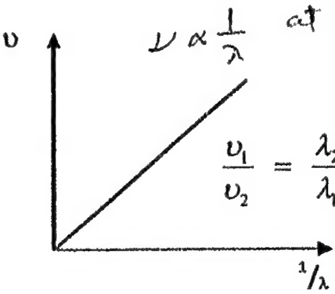
$V \propto \lambda$ at const (ν)



$$\frac{V_1}{V_2} = \frac{\lambda_1}{\lambda_2}$$

$$\text{Slope} = \frac{V}{\lambda} = \upsilon$$

$\nu \propto \frac{1}{\lambda}$ at const (V)

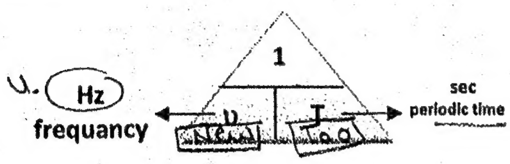


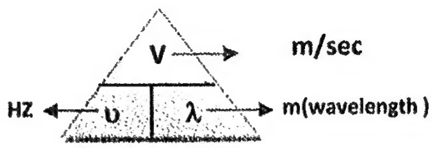
$$\frac{\upsilon_1}{\upsilon_2} = \frac{\lambda_2}{\lambda_1}$$

$$\text{Slope} = \upsilon \div \frac{1}{\lambda} = \upsilon\lambda$$

$$\text{Slope} = v$$

Laws :





1) $\upsilon = \dfrac{\text{No. of waves}}{\text{time in sec.}}$

- طول الـ wave الواحدة = λ
- زمن الـ wave الواحدة = T

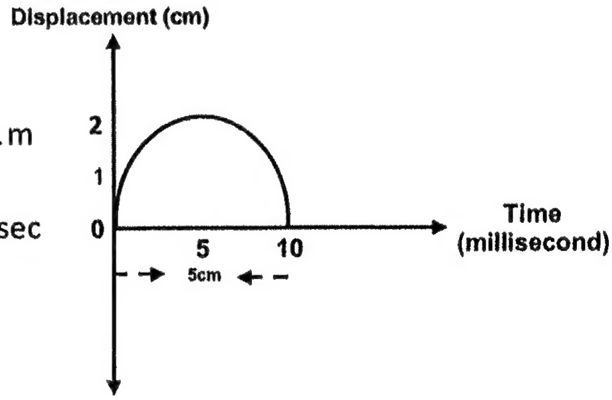
2) $\text{No. of waves} = \dfrac{\text{total distance}}{\lambda} = \dfrac{\text{Total time}}{T}$

3) $V = \dfrac{\text{Total distance}}{\text{total time}} = \dfrac{\lambda}{T} = \lambda\,\upsilon$

Note : **1) Same source (vibrator)** $\quad \therefore$ **υ constant V α λ (two medium)** $\dfrac{V_1}{V_2} = \dfrac{\lambda_1}{\lambda_2}$

2) Same medium $\quad \therefore$ **V constant** $\quad \therefore \upsilon \propto \dfrac{1}{\lambda} \quad \dfrac{\upsilon_1}{\upsilon_2} = \dfrac{\lambda_2}{\lambda_1}$

- **Amplitude = 2 cm = 0.02 m**
- $\upsilon = \dfrac{\text{no. of wave}}{\text{time in sec}} = \dfrac{0.5}{10\times10^{-3}} = 50\,\text{Hz}$
- $\dfrac{1}{2}\lambda = 5\times10^{-2} \qquad \therefore \lambda = 5\times10^{-2}\times2 = 0.1\,\text{m}$
- $\dfrac{1}{2}T = 10\times10^{-3} \qquad \therefore T = 2\times10^{-2} = 0.02\,\text{sec}$
- $V = \dfrac{d}{t} = \dfrac{5\times10^{-2}}{10\times10^{-3}} = 5\,\text{m/s}$
- **Or V = λ υ = 50 × 0.1 = 5 m/s**



<u>From the fig. find :</u>

1) A **2) υ** **3) λ**

4) T **5) velocity** **6) complete vibration**

Complete Vibration = 4 A = 4 × 0.02 = 0.08

Questions

What is meant by :

1- Crest
2- Trough
3- Compression
4- Rarefaction
5- Distance between first crest and tenth crest = 180 cm
6- Time between 1st crest and tenth crest = 18 sec.
7- Distance between 2nd crest and 5th trough = 35 cm .
8- Time between 2nd trough and 5th crest = 0.5 sec .
9- Distance between 2nd compression and 4th rarefaction = 0.5 m.

Write scientific term :

1- Distance between 2 successive crest and trough . $\frac{\lambda}{2}$ of Transverse wave ($\frac{1}{2}$ wave length)
2- Distance between the centers of successive compression and rarefaction . $\frac{1}{2}$ wave length of longitudinal wave
3- The length of compression and rarefaction . wave length
4- The length of compression or rarefaction . $\frac{1}{2}$ wave length

Answer what is meant by :

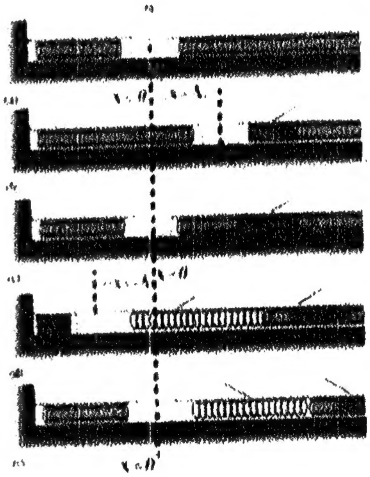
1- Crest
Maximum displacement upward in a transverse wave (+ve direction)
2- Trough
Maximum displacement downward in a transverse wave (-ve direction)
3- Compression
It is the region in which particles of medium are too close to each other in longitudinal wave .
4- Rarefaction
It is the region in which particles of medium are too far To each other in longitudinal wave .
5- Distance between first crest and tenth crest = 180 cm
no. of waves = 10 – 1 = 9 waves
$9\lambda = 180$ cm
$\lambda = 20$ cm
Distance between 2 successive crests or troughs is 20 cm .
6- Time between 1st crest and tenth crest = 1.8 S.
no. of waves = 10 – 1 = 9 waves
$9T = 1.8$ sec
$T = 0.2$ sec
time of one complete vibration is 0.2 sec.

7- Distance between 2^{nd} crest and 5^{th} trough = 35 cm .
no. of waves = (5 – 2) + 0.5 = 3.5 waves
$3.5\,\lambda = 3.5$ cm
$\lambda = 10$ cm
distance between 2 successive crests or troughs is 10 cm

8- Time between 2^{nd} trough and 5^{th} crest = 0.5 sec .
no. of waves = (5 – 2) - 0.5 = 2.5 waves
$2.5\,T = 0.5$ sec
$T = 0.2$ sec
Time of 1 complete vibration is 0.2 sec.

9- Distance between 2^{nd} compression and 4^{th} rarefaction = 0.5 m.
no. of waves = (4 – 2) + 0.5 = 2.5 waves
$2.5\,\lambda = 0.5$ m
$\lambda = 0.2$ m

Longitudinal waves



*Exp:

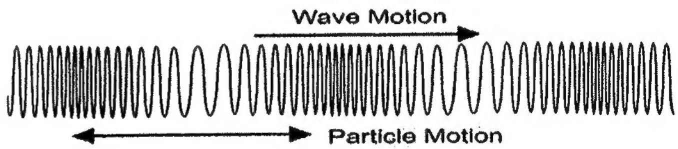
1- Pull the mass (m) to the right distance (x =A)

obs:

2- Part of the spring to the right of A is compressed
3- this compression is transmitted successively to the right

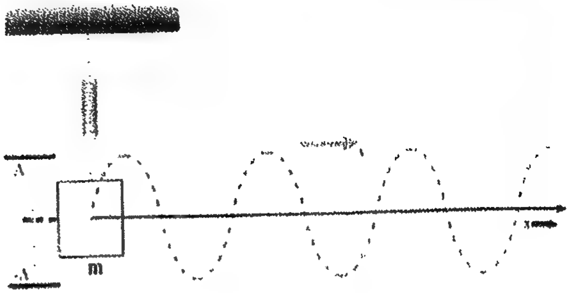
Exp :

4- Pull the mass(m) to the position (x = -A)
5- the spring to the right of the mass (m) elongates forming a rarefaction which spreads to the right
6- When the mass (m) goes back to the rest position [x = 0] the successive compression and rarefactions form a longitudinal wave preformed by particles of medium .



Explain an Exp. to demonstrate longitudinal wave

Transverse waves



Exp:

- When the mass (m) performs a simple harmonic motion in the vertical direction.

Obs. :

- The near end of the rope performs the same motion consequently the following parts of the rope do the same thing the motion transfers horizontally along the rope in the form of a wave called transverse wave.

S waves are transverse waves

Note:

- The parts of the rope oscillate vertically in simple harmonic motion about their rest positions.
- Explain an Exp. to demonstrate transverse wave

Questions Chapter (1) : Wave

1) Define

Wave

disturbance that propagate and Transfer energy along its direction of propagetion

Transverse Wave

particles of medium vibrate perpendicular To The direction of wave propagetion

Longitudinal Wave

particles of medium vibrate along to the direction of wave propagetion

Wavelength

distance between Two successive crests or troughs

[or] distance between The center of Two successive compressions or rarefaction

2) Complete:

a) Displacement is distance between the position of vibration body at any instance and its position of rest

b) Amplitude of oscillation is its the maximum displacement for vibrating body

c) Complete oscillation is it produced when vibrating body passed by a fixed point Two successive Time in one direction

d) Periodic time is the Time of one complete vibration

e) Frequency is it's number of complete vibration in one second

3) Essay question:

Deduce the relation between frequency, wavelength and velocity of wave propagation.

Proof

Velocity = wavelength x Frequency $V = \lambda \cdot \nu$

$V \propto \lambda$ at const. ν ((direct relation))

$V \propto \nu$ at const. λ ((direct relation))

$\lambda \propto \frac{1}{\nu}$ at const. V λ direct relation with $\frac{1}{\nu}$

λ inverse relation with ν

4) Put a tick sign (✓) next to the right choice in the following:

1) The relation between the velocity of propagation of the waves "v" in a medium, its frequency and wavelength is:

a) $v = \lambda\nu$ b) $V = V/\lambda$

c) $V = \frac{\lambda}{V}$ d) none (there is no correct answer)

2) Transverse waves are waves consisting of:

a) Compressions and rarefactions

b) Crests and troughs

c) Crests and troughs, where the particles of the medium move short distances about their equilibrium positions in a direction perpendicular to the direction of propagation.

d) Compressions and rarefactions, where the particles of the medium move: short distances about their equilibrium positions along the direction of propagation of the wave.

3) If the wavelength of a sound wave produced by an audio (sound producing) source is 0.5 m, the frequency is 666 Hz ,then the velocity of propagation of sound in air is:

$\lambda = 0.5$ m
$\nu = 666$ Hz
$V = \lambda \cdot \nu = 0.5 \times 666$

a)338m/s b)333 m/s c)330m/s d)346m/s

4) If the velocity of sound in air is 340 m/s, for a sound of frequency (tone) 225 HZ, the wavelength(m) is:

$V = 340$ m/s
$\nu = 225$ Hz
$\lambda = ??$

a) 4/3 b) 3/4 c) 20 d) 3/2

$V = \lambda\nu$
$\lambda = \frac{V}{\nu} = \frac{340}{225} =$

$\lambda = 6000 \times 10^{-10}$ $\quad V = 300 \times 10^3$ m/sec

5) Light of wavelength 6000A°(1A°=10^{-10}m) propagates in space at velocity 300×10^3 .... its frequency is:

$V = \lambda \nu$ $\quad \nu = \frac{V}{\lambda} = \frac{300 \times 10^3}{6000 \times 10^{-10}} = 5 \times 10^{11}$ Hz

(a) 4×10^{10} Hz (b) 4×10^{14} Hz (c) 5×10^{14} Hz (d) 5×10^{12}Hz

6) Two waves whose frequencies are 256 Hz and 512 Hz propagate in a certain medium, the ratio between their wavelengths is

a) 2/1 b) 1/2 c) 3/1 d) 1/3

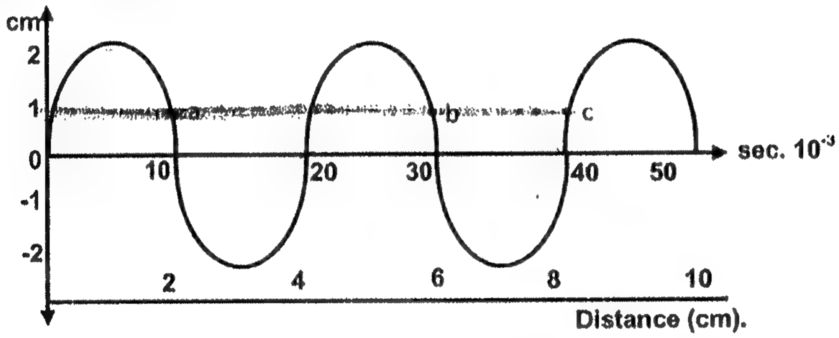
256 : 512

Problems

1) From the fig. find:

1. Periodic time. 20×10^{-3} sec
2. Frequency. $\frac{1}{20 \times 10^{-3}} = 50$ Hz

If the displacement is drawn with ratio 1 : 5 and the distance is drawn with ratio 1 : 250 find :



1. The wave length (λ)
2. Velocity of propagation (V).
3. Amplitude (A).
4. The distance (ab) represents ...λ... and equals ...10 m...
5. The two points a ,b are ....in phase.... While the two points a.c. are out of phase

$2.5 \lambda = 10 \times 10^{-2} \times 250$

$\lambda = 10$ m

$V = \lambda \nu = 10 \times 50 = 500$ m/sec

$A = 2 \times 10^{-2} \times 5 = 0.1$ m

2) A train emits sound of wavelength 0.8 m and frequency 400 Hz find the velocity of sound in air.

$V = \lambda \nu = 0.8 \times 400 = 320$ m/sec

$\lambda = 0.8$ m
$\nu = 400$ Hz

3) The number of water waves passing a certain point on its path through 2 sec. Is 12 waves each of wave length 0.1m. calculate the wave velocity in water.

$T = 2$ sec
No. of wave = 12
$\lambda = 0.1$ m

$\nu = \frac{\text{No. of waves}}{\text{Time}} = \frac{12}{2} = 6$ Hz

$V = \lambda \nu = 0.1 \times 6 = 0.6$ m/sec

No. of waves $= \frac{t}{T}$

$12 = \frac{2}{T}$

$T = \frac{2}{12} = \frac{1}{6}$ sec

$V = \frac{\lambda}{T} = \frac{0.1}{\frac{1}{6}} = 0.6$ m/s

No. of waves $= \frac{\text{distance}}{\lambda}$

$12 = \frac{d}{0.1}$

4) The light wave velocity in space is $3X10^5$ km/s given that the wave length of the green light is 5500 A° find the frequency of green light.

$V = 3 \times 10^5$ Km/s
$V = 3 \times 10^5 \times 10^3$ m/s
$\lambda = 5500\ A^\circ$
$= 5500 \times 10^{-10}$ m
$\nu = ??$

$V = \lambda \nu$

$\nu = \frac{V}{\lambda}$

$= \frac{3 \times 10^5 \times 10^3}{5500 \times 10^{-10}} = 5.45 \times 10^{14}$ Hz

5) A broadcasting station sends electromagnetic waves with wave length 5 cm to a radio set at 3 km apart given that the velocity of electromagnetic waves is 3×10^8 m/s find :

a. The frequency of the wave. b. The time taken by the wave to reach the set.

c. No. of complete waves between the station and the set.

$\lambda = 5\ cm = 5 \times 10^{-2}\ m$

$d = 3\ Km = 3 \times 10^{3}\ m$

$V = 3 \times 10^{8}\ m/s$

a) $V = \lambda \nu$

$3 \times 10^8 = 5 \times 10^{-2}\ \nu$

$\nu = \dfrac{3 \times 10^8}{5 \times 10^{-2}} = 6 \times 10^9\ Hz$

b) $t = \dfrac{distance}{V} = \dfrac{3 \times 10^3}{3 \times 10^8} = 10^{-5}$

c) No. of waves $= \dfrac{d}{\lambda} = \dfrac{3 \times 10^3}{5 \times 10^{-2}} = 60000$ waves

6) A transverse wave has a frequency 42 Hz and the distance between the first and the tenth crest is 135 cm find the wave velocity.

$\nu = 42\ Hz$

$d = 135\ cm$

No. of waves = 9

$9\lambda = 135 \times 10^{-2}\ m$

$\lambda = 0.15\ m$

$V = \lambda \nu$

$= 0.15 \times 42 = 6.3\ m/sec$

7) Water waves-covers 600 m through 2 minutes and the distance occupied by 5 complete waves if 0.5 m find : a. The no. of complete waves occupies 5 m.

b. The frequency of the wave.

$d = 600\ m$

$t = 2\ min = 120\ sec$

$5\lambda = 0.5\ m$

$\lambda = 0.1\ m$

No. of waves $= \dfrac{distance}{\lambda} = \dfrac{5}{0.1} = 50$ wave

$V = \dfrac{d}{t} = \dfrac{600}{120} = 5\ m/sec$

$\nu = \dfrac{V}{\lambda} = \dfrac{5}{0.1} = 50\ Hz$

8) Audible sounds are that of frequency between 20 to 20.000 Hz given that the velocity of sound in air = 340 m/s find maximum and minimum wave length of audible sounds.

$\lambda_{max} = \frac{V}{\nu_{min}}$

$\lambda_{min} = \frac{V}{\nu_{max}}$

$\nu = 20$ Hz

$\nu = 20.000$ Hz

$V = 340$ m/s

$V = \lambda \nu$

$\lambda = \frac{V}{\nu}$

minimum $\lambda = \frac{340}{20000} = \frac{17}{1000} = 0.017$ m

maximum $\lambda = \frac{340}{20} = 17$ m

9) A straight vibrator causes water ripples to travel across a surface of a shallow tank the waves travel a distance 33 cm in 1.5 sec and the distance between 2 successive wave crests is 4 cm find the frequency of the vibrator.

$d = 33$ cm

33×10^{-2} m

$t = 1.5$ sec

$\lambda = 4$ cm

4×10^{-2} m

$\nu = ??$

$V = \frac{d}{t} = \frac{33 \times 10^{-2}}{1.5} = 0.22$ m/s

$V = \lambda \nu$

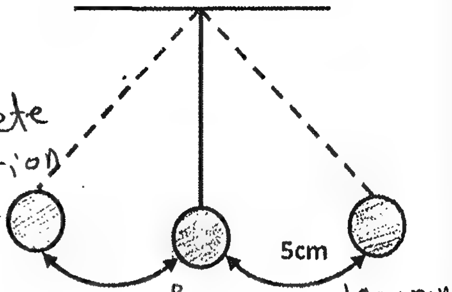
$\nu = \frac{V}{\lambda}$

$= \frac{0.22}{4 \times 10^{-2}} = 5.5$ Hz

10) The following diagram represents a simple pendulum.It produces 100 vibrations in 5 sec find :

a) The frequency. **b) The amplitude.** e) complete vibration

c) The periodic time. d) velocity of wave.



No. of waves = 100 wave

$t = 5$ sec

$\frac{1}{4}\lambda = 5$ cm

$\lambda = 20$ cm

20×10^{-2} m

$\nu = 20$ Hz

a) $\nu = \frac{\text{No. of wave}}{t}$

$= \frac{100}{5} = 20$ Hz

b) amplitude $= 5$ cm $= 5 \times 10^{-2}$ m

c) $T = \frac{t}{\text{No. of wave}} = \frac{5}{100}$

$= 0.05$ sec

d) $V = \lambda \nu$

$= 20 \lambda$

e) $4A = 4 \times 5 \times 10^{-2} = 0.2$ m

11) Two waves their frequencies 512, 256 Hz respectively propagate in a certain medium find the ratio between their wavelengths.

$\nu_1 = 512$

$\nu_2 = 256$

$V = \lambda \cdot \nu$

λ inverse relation with ν at const V

$\frac{\nu_1}{\nu_2} = \frac{\lambda_2}{\lambda_1}$

$\frac{\nu_1}{\nu_2} = \frac{512}{256} = 2$

$\frac{\lambda_2}{\lambda_1} = 2$

$\lambda_1 : \lambda_2$

$1 : 2$

자이납

Questions – Student self evaluation guide

Chapter one

First: Multiple choice questions:

The questions in this group are followed by several proposed answers,

Select the best answer for each question:

1- A girl on the beach watching water waves ,sees 4 waves passes in 2 seconds, each with a wavelength of 0.5 m .the speed of the wave is

No. of wave = 4
$t = 2$ sec
$\lambda = 0.5$ m
$V = ??$
$\nu = \frac{4}{2} = 2$
$V = \lambda \nu = 0.5 \times 2 = 1$ m/s

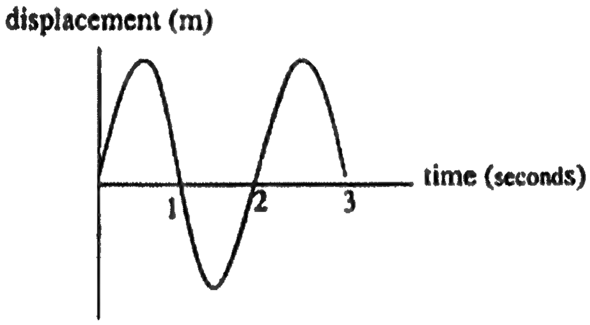
a) 0.25 m/s *b)* 0.5 m/s

c) 1.0 m/s *d)* 0.2 m/s

e) 4.0 m/s

2-A pendulum oscillates in a simple harmonic motion as represented by the figure below. The frequency of the pendulum is:

$\nu = \frac{\text{No. of wave}}{t} = \frac{1.5}{3}$
$\nu = 0.5$ Hz



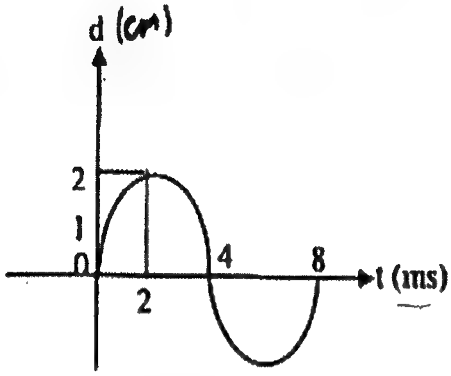
a) 3 Hz b) 2 Hz

c) 1Hz d) 0.5 Hz

e) 0.33 Hz

Questions (3-4):

The figure below represents a wave drawn exactly to scale



3- The amplitude of this wave is

a) 2 cm
b) 3 cm
c) 4 cm
d) 6 cm

4- The frequency of this wave is

a) 100 Hz
b) 125 Hz
c) 250 Hz
d) 500 Hz

$0.125\ Hz \times 10^{-3}$

5- Sound is an example of:

a) electromagnetic wave.
b) longitudinal wave
c) transverse wave.
d) circular wave

6- The wave on a lake causes a buoy to oscillate up and down 90 times per minute. The frequency of the waves in hertz is

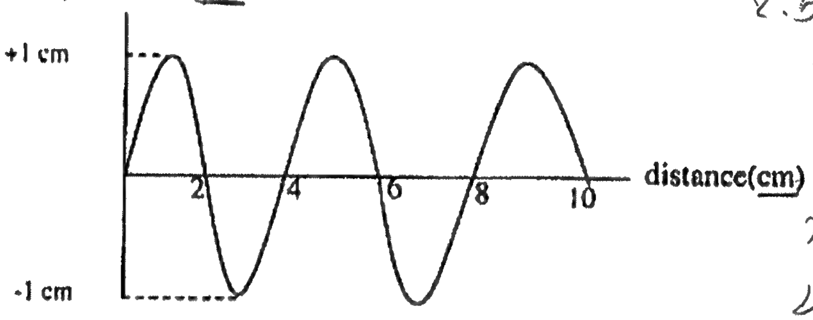
a) 90 Hz
b) 60 Hz
c) 1.5 Hz
d) 0.6 Hz
e) 0.67 Hz

No of wave = 90
t = 60 sec
$\nu = \frac{\text{No of wave}}{t}$
$\frac{90}{60} =$

Questions (7-8):

The figure below represents a wave propagating along a string with speed of 330 m/s

$V = 330\ m/s$



$2.5\lambda = 10 \times 10^{-2}$

$\lambda = 0.04$

$\lambda = 4 \times 10^{-2}\ m$

$\nu = \frac{V}{\lambda} = \frac{330}{4 \times 10^{-2}}$

7- The frequency of the wave is

a) 1280 Hz b) 640 Hz

c) 320 Hz d) 8250 Hz

e) 400 Hz

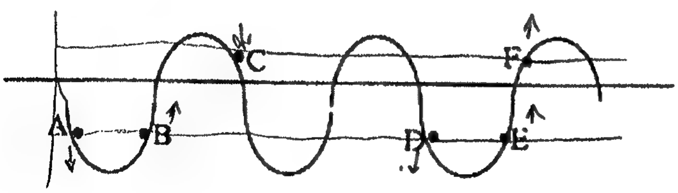
8- The amplitude of the wave is

a) 1 cm b) 2 cm

c) 4 cm d) 8 cm

e) 16 cm

9- Which point in the wave shown in the below diagram is in phase with point A



[A, B, D, E] same displacement

[A, D] same direction

[B, E] same direction

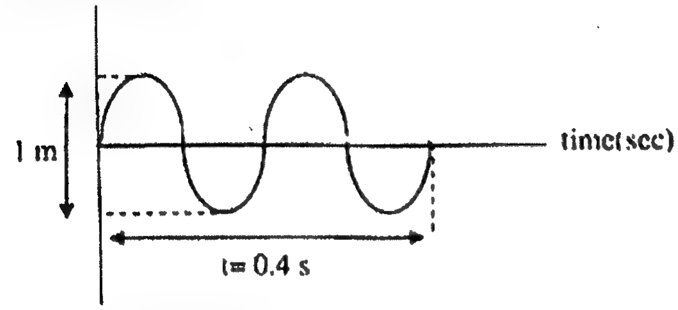
A, D inphase

B, E in phase

a) F b) B c) C d) D e) E

Question (10-11):

The following figure represents a wave motion



10- The amplitude of this wave is

a) 0.5 m b) 1m c) 2 m d) 4 m e) 6 m

11- The frequency of this wave is $\frac{\text{No. of wave}}{t} = \frac{2}{0.4} =$

a) 2 Hz b) 4 Hz c) 5 Hz d) 0.4 Hz e) 0.2 Hz

12- Dolphins can communicate by emitting sound of frequency 150000 Hz. If the speed of sound in water is 1500 m/s the wavelength of these sounds will be:

$\lambda = \frac{v}{\nu} = \frac{1500}{150000}$

a) 10 m b) 1 m c) 0.1 m d) 0.01 m e) 0.001 m

13- Which of the following longitudinal wave?

a) Infra red radiation b) Gamma radiation

c) Sound waves in air c) Radio wave in space

c) Light waves

14- The curve OPQRS below represents a wave of frequency 50 Hz. What is the time interval between points O and P.

$\nu = \frac{\text{No. of wave}}{t}$

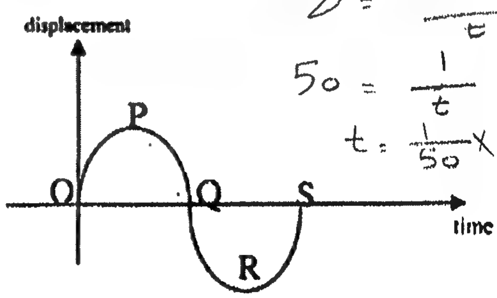
$50 = \frac{1}{t}$

$t = \frac{1}{50} \times \frac{1}{4} = \frac{1}{200}$

a) $\frac{2}{25}$ s b) $\frac{1}{25}$ s

c) $\frac{1}{50}$ s d) $\frac{1}{100}$ s

e) $\frac{1}{200}$ s



$V = \lambda \nu$

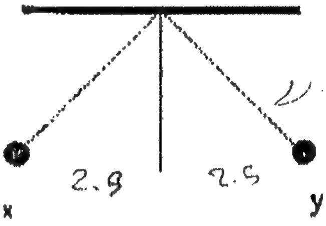
15- When the frequency of a wave motion decreases:

a) Wavelength is increased b) Wavelength is decreased

c) Speed is decreased d) Speed is increased

e) Wavelength is decreased and speed is increased

16- The ball of a simple pendulum pulled aside, and then left to move freely. It takes 5 sec to move between two point X and Y, then the frequency of vibration will be:



$\nu = \frac{\text{No. of wave}}{t} = \frac{0.5}{5} = 0.1$

a) 50 Hz b) 10 Hz c) 5 Hz d) 0.2 Hz e) 0.1 Hz

17- What kind of these waves can transfer in space?

a) Light waves b) Sound waves c) Water waves

d) The wave produced in tension string

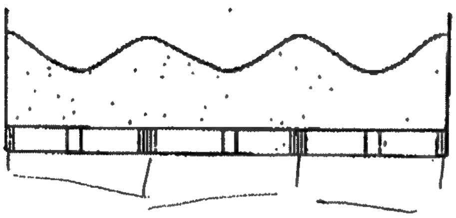
Questions (18-20):

The figure represents a longitudinal wave moving through water in a glass tank of length 9 m. The frequency of the wave is 500 Hz

$\text{No. of wave} = \frac{d}{\lambda}$

$\lambda = \frac{d}{\text{No. of wave}} = \frac{9}{3} = 3$

$V = 3 \times 500 = 1500$



18- This wave could be which of the following types of waves?

a) visible light b) radio wave

c) micro wave d) sound wave

c) x- ray

19- What is the wavelength of the longitudinal wave?

a) 1.5 m b) 3 m c) 4.5 m d) 9 m e) 18 m

20- The speed of the wave is most nearly

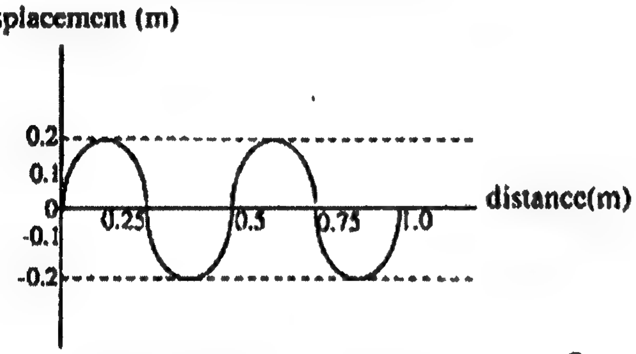
a) 500 m/s b) 750 m/s

c) 1500 m/s d) 3000 m/s

e) 4500 m/s

Second: structure questions:

1- consider the following diagram of a wave:



a) The wavelength of the wave =......0.5 m........

b) The amplitude of the wave =........0.2 m.........

If the speed of the wave is 12 m/s

c) The frequency of this wave =.. $\frac{V}{\lambda} = \frac{12}{0.5} = 24$ Hz..........

d) The period of the wave =........ $\frac{1}{24}$ sec................

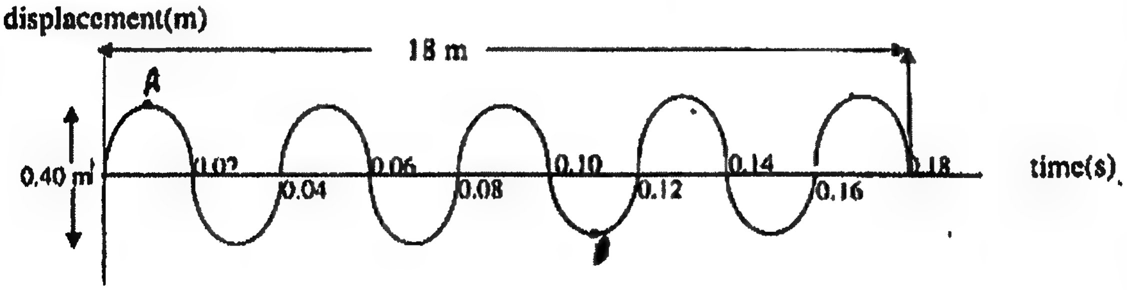
$v = \frac{d}{t}$

$t = \frac{d}{v} = \frac{1}{24}$ sec

$T = \frac{t}{\text{No. of wave}} = \frac{\frac{1}{24}}{2}$

$= \frac{1}{48}$

2-The given figure show a relation between the displacement in meter and time in seconds for transverse wave. From this figure find:



1- The amplitude = ...0.20.......... m

$V = \frac{d}{t} = \frac{18}{0.18} = 100$

2- The wavelength =...$\frac{18}{4.5}$ = 4....... m

$V = \lambda \nu$
$\nu = \frac{V}{\lambda} = \frac{100}{4} = 2.5$

3- The frequency =........2.5.............. Hz

4- The periodic time = $\frac{t}{\text{No. of wave}} = \frac{0.18}{4.5} = 0.04$ sec

5- The number of the waves =...4.5......waves.

6- The distance between A and B =........18..........m.

and the number of the waves in this distance =......2.5...........waves.

7- The wave velocity = ...100...... m/s

Third: Short Essay questions:

1- Define each of the following:

The transverse wave – The longitudinal wave – The amplitude – The complete vibration – The periodic time – The frequency – Electromagnetic wave.

3- What is meant by?

a) The wavelength of water waves = 0.4 m

b) The wavelength of sound waves = 1.6 m

c) A body is doing 1200 complete vibration in one minute

d) The distance between first and third crest in transverse wave = 20 cm

e) The periodic time for a vibrating body = 0.02s

f) The amplitude of a vibrating motion = 6 cm

g) The speed of a wave = 1.5 m/s

h) In a transverse wave, the distance between two successive crest and trough = 20 cm

Fourth: Problems:

1- An oscillating body of frequency 960 Hz, find the number of waves formed until the oscillations reach a person standing at distance 100 meters from the source (Velocity of sound 320 m/sec) **[1/3 m, 300 waves]**

2- Calculate the frequency of wireless wave of velocity 3×10^8 m/sec, and wave length 40 m. **[7.5×10^6 Hz]**

$V = 3 \times 10^8$ m/sec
$\lambda = 40$ m

$\nu = \frac{V}{\lambda} = \frac{3 \times 10^8}{40} = 7.5 \times 10^6$ Hz

3- Wireless station emits waves of velocity 3×10^8 m/sec, towards a satellite after 0.03 second the same station receive the waves using a radar. Calculate the distance between the station and satellite. **[4.5×10^3 Km]**

4- A transverse wave propagates through a string with velocity 600 m/sec. If the distance between two successive crests is 3 meters. Find the frequency of such wave. **[200 Hz]**

5- An oscillating source of frequency 100 Hz. Find the time between the passage of the first crest and the 20th one through a point in the direction of propagation of the wave. **[0.19 sec]**

6- A wave generator produces 16 pulses in 4 sec. Find the frequency and its periodic time. **[0.25 sec, 4 Hz]**

7- A train stops in station and makes a sound with frequency = 300 Hz. If a man is stopping at a distance = 0.99 Km, from the train hears the sound after 3 sec. From the beginning of the sound. Calculate the wavelength of this sound. **[1.1 m]**

8- If 15 waves per minute pass by a man stopping at the end of a stone in the sea and he observes that each wave occupies a distance = 9 m. Find the following: Period – frequency – wavelength – speed of waves

9- Sound wave with frequency 1.1 K Hz. If it is known that the speed of sound in air = 330m/s. Calculate the wavelength of this wave in air. **[0.3 m]**

10- Calculate the wavelength of a sound wave propagated in water with the frequency 700 Hz. Knowing that the speed of sound in water is 1.4 Km.

[2 m]

11- A simple pendulum makes 1200 complete vibrations in a minute. In each complete vibration it cuts a distance of 20 cm. Calculate:

a) The amplitude of the vibration of the pendulum
b) The frequency
c) Periodic time **[5 cm, 20 Hz, 0.05 sec]**

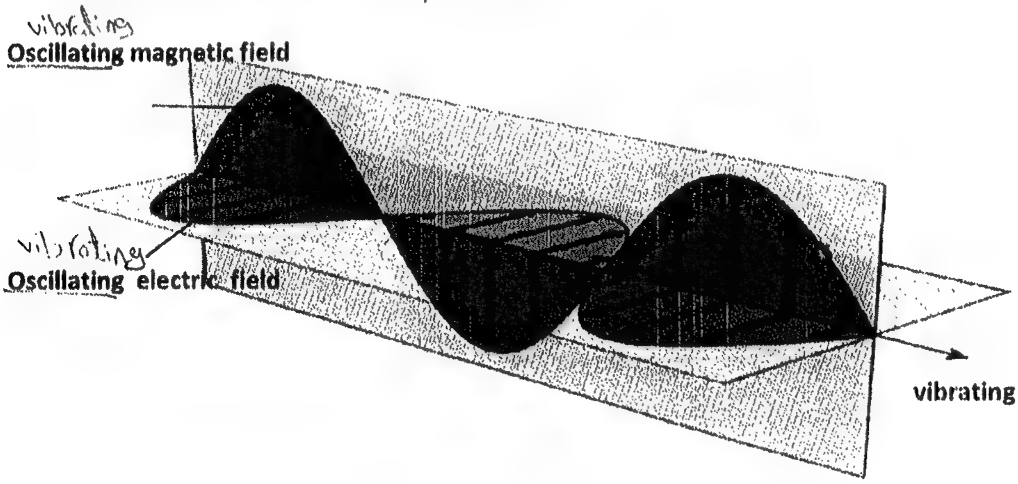
Chapter (2) : Light as a wave Motion

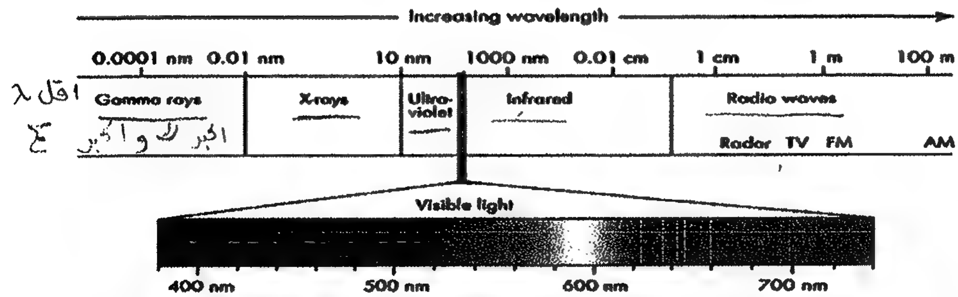
Introduction:

دليل على ذلك

Light travels in all directions in straight lines: The evidence for that is the formation of umbra and penumbra.

- G.R.: light is a wave motion
  Because light reflects, Refracts, interfere and diffracts, so it has the same general properties as wave.
- G.R.: Light does not require a medium to propagate. why?
  Because it consists of vibrating electric field and magnetic field ⊥ to each others and to wave propagation .
- Light is a part of an extensive range, of waves called electromagnetic waves which :
  1) Travel at constant speed in space 3×10^8 m/sec
  2) They have different (ν) and (λ) . Frequency – wavelength
  3) They all transverse electromagnetic waves .
  4) There is no sharp limit between them .





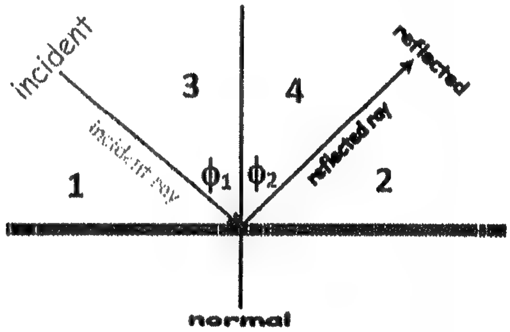
Electromagnetic waves :

Similarities	Differences
1- All of them are transverse wave 2- Have constant speed 3×10^8m/sec in space and air.	Have different : 1- Frequency (υ) 2- Wavelength (λ) 3- Energy .

Reflection and refraction

- If a ray of light falls on an interface that separates two transparent media .
- A portion of that ray reflects in the first medium and the other portion of the ray refract in the second medium .

1) Reflection of light :



Incident ray (1): It is the ray that falls on the reflecting surface .

Reflected ray (2): It is the ray that reflects from the reflecting surface .

The angle of incidence(3): It is the angle between the incident ray and the normal.

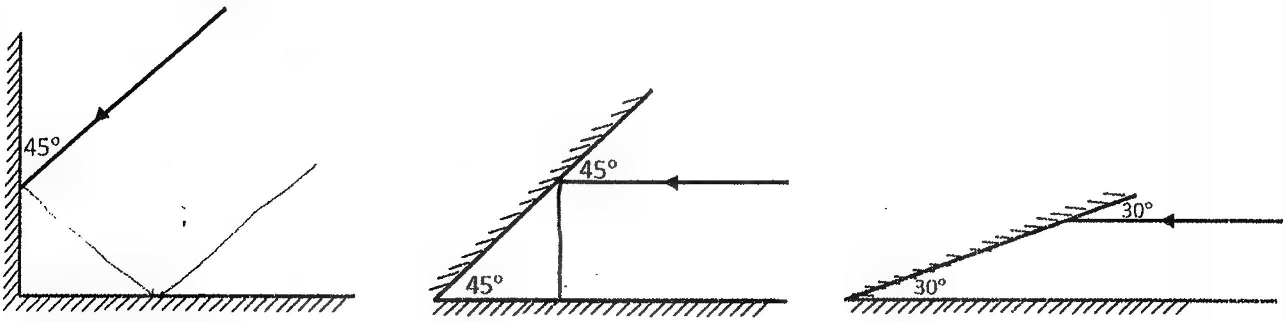
Angle of reflection (4) : It is the angle between the reflected ray and the normal .

The two laws of reflection :

1) The angle of incidence is equal to the angle of reflection

2) The incident light ray , the reflected ray and the normal all lie in one plane ⊥ to the reflecting surface .

Trace the path of the ray then comment

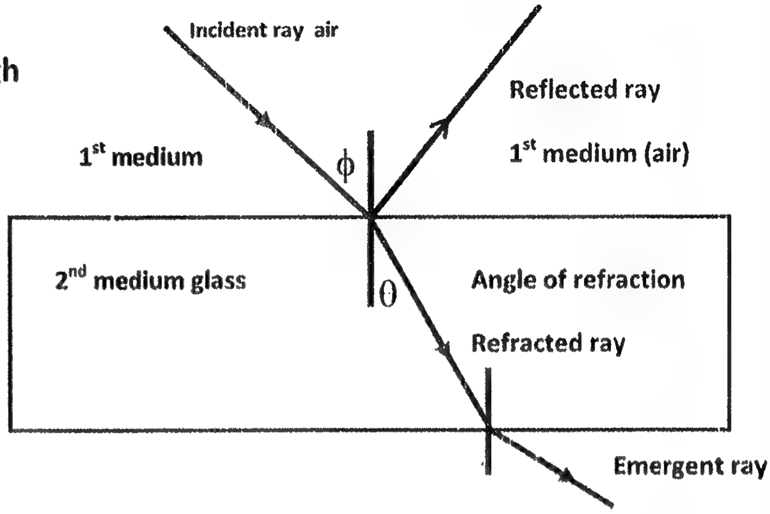


The refracted ray :

It is the ray passes through the second medium .

The angle of refraction:

It is the angle between the refracted ray and the normal to the separating surface .



The two laws of refraction :

1) The ratio between the sine of the angle of incidence to sine the angle of refraction is constant and is known as the relative refractive index between the two media $_1n_2 = \frac{\sin\phi}{\sin\theta}$
2) The incident light ray and the refracted light ray and the normal to the surface of separation all lie in one plane ⊥ to the surface of separation .

G.R.F. :

1- Light refract when passing from medium to another .

sol. due to difference in velocity & optical density from medium to another .

2- The perpendicular ray shows no refraction (passes in straight line) .

Sol . Bec. Angle of incidence = angle of refraction = zero .

3- The bottom of swimming pool appears higher

4- a spoon in glass of water seems to be broken .

Sol . due to light refraction when passing from medium to another , so we see at the extension of refracted ray .

5- The ⊥ Ray reflect on it self .

sol . Angle of incidence = angle of reflection equal zero .

6- Light refracts between two media .

sol . due to change in the velocity of light in the two media so that :

$$\frac{\sin\phi}{\sin\theta} = \frac{V_1}{V_2} = \frac{\lambda_1}{\lambda_2} = {}_1n_2$$

Optical density of a medium :

- It is ability of the medium to (bend) refract light rays when they pass through it .
- Velocity of light in space ($C = 3 \times 10^8$ m/s) is greater than velocity of light in any other medium .
- $n = \frac{C}{V}$ when light ray passes from air to any other medium (n) is called absolute refractive index of the medium .

G.R : The absolute refractive index of any medium is greater than one .

Velocity of light in air is greater than any other medium .

- When light ray passes from air two different media .

Proof

غير مهم

غير موجود في الدليل التدريبي

$\therefore n_1 = \frac{C}{V_1}$ $\therefore n_2 = \frac{C}{V_2}$ $\therefore \frac{n_2}{n_1} = \frac{c}{V_2} \div \frac{c}{V_1}$

$\frac{n_2}{n_1} = \frac{V_1}{V_2}$ $\therefore {}_1n_2 = \frac{n_2}{n_1} = \frac{V_1}{V_2} = \frac{\text{Sin}\,\phi}{\text{Sin}\,\theta} = \frac{\lambda_1}{\lambda_2}$

Define : The relative refractive index between two media .

1) It is the ratio between the absolute refractive index of the second medium to that of the first medium .
2) It is the ratio between the velocity of light in the first medium to that in the second medium .
3) It is the ratio between sine the angle of incidence in the first medium to sine the angle of refraction in the second medium .

$\because \frac{n_2}{n_1} = \frac{\text{Sin}\,\phi}{\text{Sin}\,\theta}$

$\therefore n_1 \text{Sin}\,\phi = n_2 \text{Sin}\,\theta$ **Snell's law**

Snell's law :

The absolute refractive index for the medium of incidence time the sine of the angle of incidence is equal to the absolute refractive index of medium of refraction times the sine of the angle of refraction .

자이납

Laws :

$${}_1n_2 = \frac{n_2}{n_1} = \frac{v_1}{v_2} = \frac{\text{Sin}\,\phi}{\text{Sin}\,\theta} = \frac{\lambda_1}{\lambda_2} = \frac{1}{{}_2n_1} > \text{or} < 1$$

$${}_wn_{glass} = \frac{n_g}{n_w} = \frac{v_w}{v_g} = \frac{\sin\phi_w}{\sin\theta_g} = \frac{\lambda_w}{\lambda_g} = \frac{1}{{}_{glass}n_w} \gtrless 1$$

$${}_{air}n_{medium} = \frac{n_{medium}}{n_{air}} = n_{medium} = \frac{C}{V} = \frac{\text{Sin}\,\phi_{air}}{\text{Sin}\,\theta_{medium}} = \frac{\lambda_{air}}{\lambda medium} > 1$$

${}_1n_2 \rightarrow$ relative refraction index from medium one to two .

$n_{medium} = n_2 \rightarrow$ absolute refraction index of 2nd medium

denser $\xrightarrow{\text{refracts away}}$ less dense

n كبيرة $\xleftarrow{\text{Refracts near}}$ n صغيرة

V , λ , angle صغيرة   V , λ , angle كبيرة

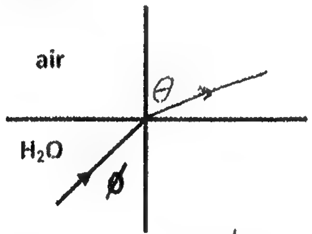
Ex. :

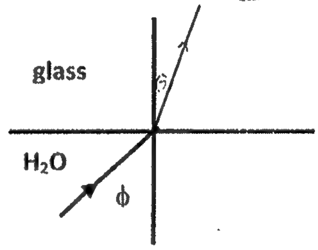
$n_{glass} = \frac{3}{2}\ \frac{9}{6}$, $n_{water} = \frac{4}{3}\ \frac{8}{6}$, $n_{air} = 1$

unitless

Bec its ratio between similar physical quantity

Show the path of ray from water to air , water glass





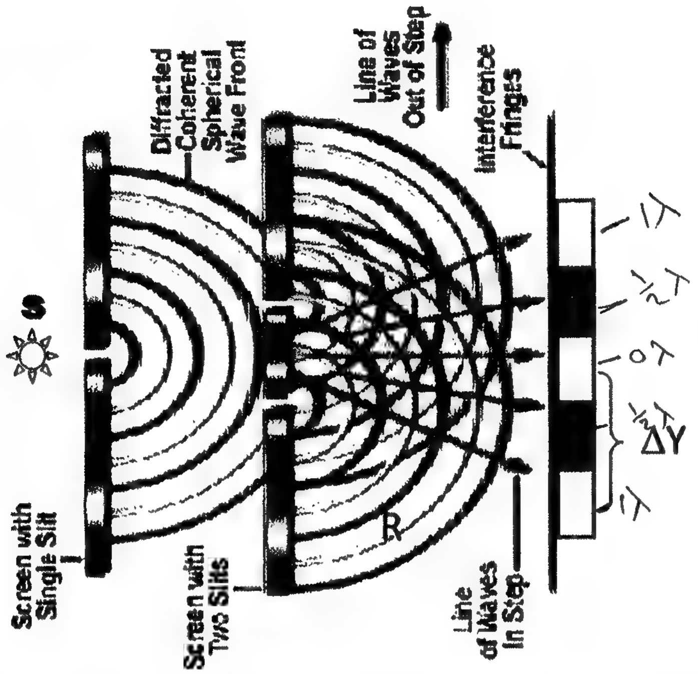
Find : 1) ${}_{glass}n_{water}$ $\frac{n_{water}}{n_{glass}} = \frac{4}{3} \times \frac{2}{3} = \frac{8}{9}$

2) ${}_{water}n_{glass}$

$\frac{n_{glass}}{n_{water}} = \frac{9}{8}$

Interference of Light

Double slite experiment by Thomas young.



1) **S** : is a mono-chromatic light source (has one λ) at a suitable distance from a narrow rectangular slit.

coherent sources

2) The waves pass to another screen having two narrow slits S_1 and S_2.

3) These double slits act as two coherent sources that means they emit waves having the same frequency , amplitude and are in phase (same velocity and direction) they are coherent .

تداخلوا

4) On the third screen the waves from the S_1 and S_2 are superposed accordingly an interference pattern occurs as extender illuminated and dark regions called (interference fringes).

- Δy : is the spacing between two successive similar ~~firings~~. Fringes (distance) (center of)
- λ : wave length of monochromatic light source . single mono length الطول الموجي يعطي لون واحد
- **R** : is the distance between the two slits (2nd screen) and the third screen. (observation screen)
- **d** : The distance separating the two slits. Such experiment can be sued to determine the wave length of mono-chromatic light: (between)

$$\boxed{\lambda = \frac{d\,\Delta y}{R}}$$

G.R.

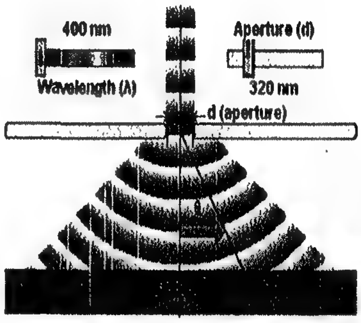
(1) The central fringe is bright
because the path difference equal zero.

(2) Interference becomes clearly by increasing (R) or decreasing (d) .

$\because \Delta y = \frac{\lambda R}{d}$ $\qquad\qquad$ $\because \lambda = \frac{d \Delta y}{R}$

- $\Delta y \,\alpha\, R$, $\Delta y \,\alpha\, \frac{1}{d}$

Diffraction of Light :



1) It is a wave phenomenon results from the change of light direction when it passes through a suitable slit or sharp edge.
2) This phenomenon is produced from the superposition of waves and formation of illuminated and dark fringes.
3) There is not essential difference between mechanism of interference and that of diffraction.
4) Diffraction is evident when the wavelength of wave is comparable to the dimension of the aperture.
5) Diffraction is the interference of secondary wavelets from different points in the slit .

What is meant by :

1- Wave front : it is a surface in which all points are in phase .

2- Coherent source : they are source producing coherent waves having same υ , A in phase .

3- Light interferences : supper position of two coherent waves having the same υ , A in phase as a result illuminated and dark regions are formed on a screen called interference fringes.

تداخل

Mention an application : اذكر استخدام

1- Double slit experiment Thomas young (exp.)
- To show " demonstrate " light interference.
- To determine wavelength of monochromatic light source .

2- Double slits in Thomas young (exp.)
- act as coherent sources .

3- Coherent sources .
- Emits waves having same frequency , amplitude and are phase

Scientific idea of :

Double slits in Thomas young (exp.)

- All points on wave front are in phase and light interference .

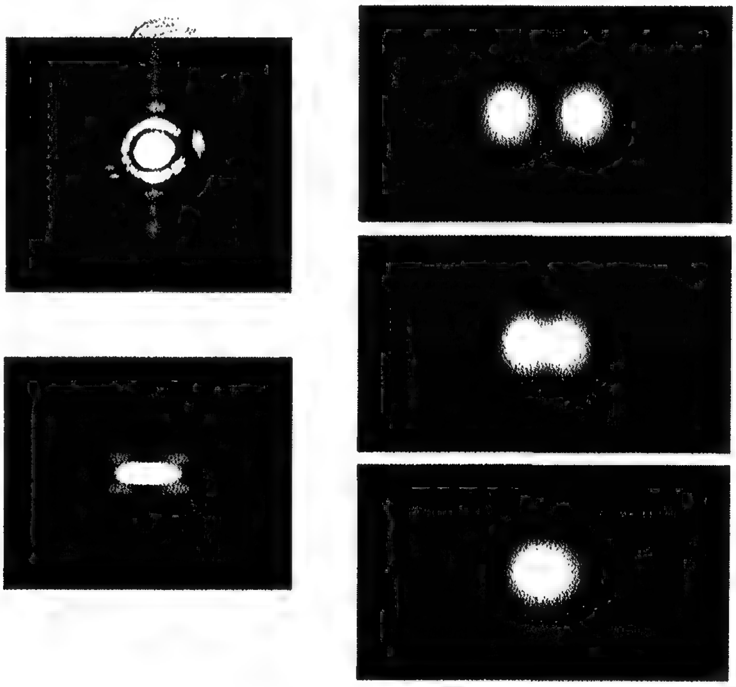
G.R.:-

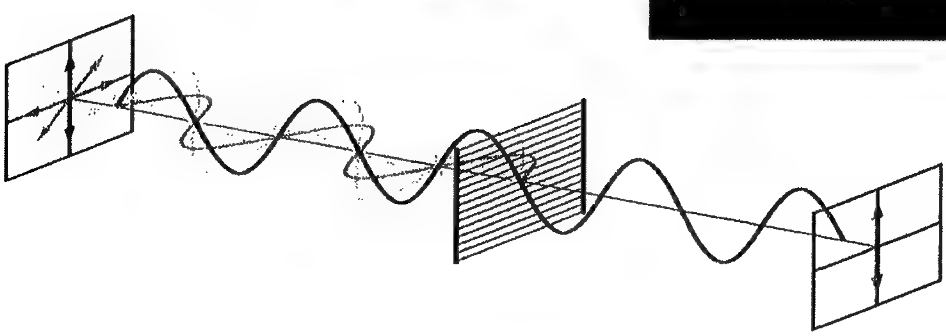
Light is a wave Motion :

- Propagates in straight lines.
- Reflects according to laws of reflection.
- Refracts according to laws of refraction.
- Light interferes and as a result light intensity increases in certain position (bright fringes) and diminishes to zero in other position (dark .fringes).
- Light diffracts if obstructed by obstacle

Airy's disk :

It is the central bright fring due to diffraction through circular aperture.





Light interference	Light diffraction
1. Super position of two coherent waves having same υ, amplitude & are in phase, as a result illuminated & dark fringes are formed (interference fringes).	1. Interference (superposition) of secondary wavelets from different point on the slit. Or change light direction due to pass by narrow slit or sharp edge
2. Interference fringes are equal in width & intensity.	2. Diffraction fringes: central one has greatest width. and greatest intensity
3. $\Delta y = \frac{\lambda R}{d}$ $\lambda = \frac{d \Delta y}{R}$	3. Diffraction more evident when (λ) comparable with opening width.

width of opening $\leq \lambda$

G.R.

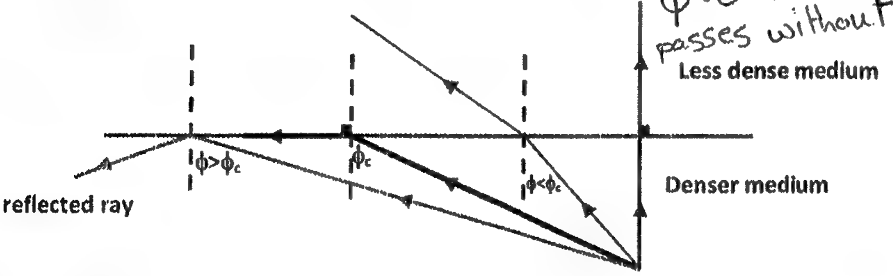
It's easy to obsenve sound diff. in our daily life but, it impossible to observe light diffraction.

λ sound is much greater than λ light so it easily to find an opening has dimension comparable with λ sound but its impossible to find it comparable with λ light.

Interference fingers	Diffraction fringes
• Equal in width. • Equal in light intensity.	• Central fringes has greatest light intensity and width.

Critical angle and total internal reflection

$\phi = \theta = 0$
passes without deviation



- **When a light ray passes from denser optical medium (water-glass) to a less dense medium (Air). It refracts away, from the normal.**

  By increasing (ϕ) (θ) increases until (θ) equal 90 (when the ray emerges parallel to the separating surface). In this case(ϕ) is called critical angle (ϕc).

Critical angle (ϕ_c)

- **It is the angle of incidence in denser medium that corresponds to an angle of refraction in the less dense medium equal (90°).**

- **By applying Senll's law.**
- $n_1 \sin\phi = n_2 \sin\theta$
- $n_1 \sin\phi_c = n_2 \sin 90$
- $n_1 \sin\phi_c = n_2$

$$\boxed{\sin\phi_c = \frac{n_2}{n_1} = {}_1n_2}$$

In general

- $n_{denser} \sin\phi_c = n_{less\ denser} \sin 90$
- $n_{denser} \sin\phi_c = n_{less\ denser}$

$$\boxed{\sin\phi_c = \frac{n_{lessdense}}{n_{denser}}}$$

- **If the less dense medium is air** $n = 1$

- $\sin\phi_c = \frac{1}{n}$ $\qquad n = \frac{1}{\sin\phi_c}$

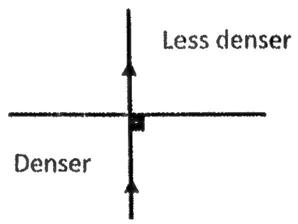
- **If the angle of incidence in the denser medium exceeds the critical angle the light ray does not pass to the less dense medium at all, but it is totally reflected within the denser medium .**

Notes :

1) $\perp$ **ray**

$\phi = \theta = 0$

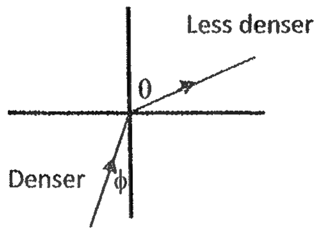
Passes without deviation



2) $\phi < \phi_c$

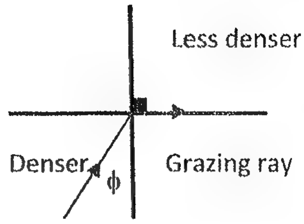
Refract a way

$\theta > \phi$ refract away from the normal ray



3) $\phi = \phi_c$, $\theta = 90$

Refracted ray // to separating surface

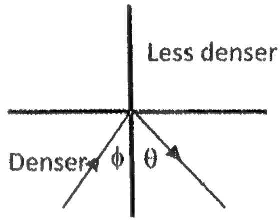


Grazing ray : (ray which coincides reflecting surface when $\phi = \phi_c$).

It is the ray which is refracted tangent to the surface when angle of incident denser medium = ϕ_c .

4) $\phi > \phi_c$

ray totally reflected in the same medium



ملحوظة هامة : ϕ_c غير موجودة على الرسم لكنها تُحسب من القانون $\sin\phi_c = \frac{1}{n}$

What is meant by :

1) $(\phi_c)_{glass} = 42°$

42° is the angle of incidence in glass that corresponding to angle of refraction in air is 90° .

2) $(\phi_c)_{water} = 48°$

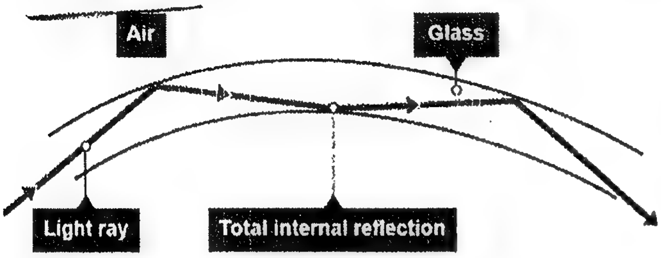
48° is the angle of incidence in water that corresponding To angle of refraction in air is 90°

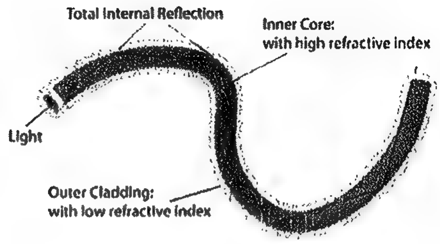
3) critical angle between glass and water = 63°

63° is the angle incidence in glass that Corresponding To angle of refraction in water is 90°

Applications for totally reflection

1-Optical fibres:





G.R. حزمة

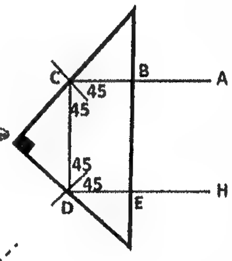
- A bundle made of thousands of fibres (optical fibre) may be used in the transporting of light, energy in medical examination and treatment because the ray of light which enters the tube suffers successive reflections because The angle of incidence is greater than the critical angle. Till it emergates from the other side
- It is a thread like tube of transparent material.
- Fibers can be used to transmit light without much losses. المنظار
- They are used in medical examination E.g. endoscopes which are used in diagnosis as well as operative surgery with a laser beam. تشخيص

G.R.

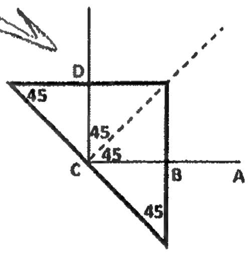
- Double layer optical fiber preferred than single layer
  → To minimize the dissipation of light intensity. يفقد
  To decrease the lose of light intensity

2- Totally reflecting prism

- It is a glass prism of angles 45,45 and 90 .
- The critical angle between glass and air is 42 .
- It may change the path of light rays by (90) or by (180). use



- It may be used in submarines (periscope). use



- Binoculars .

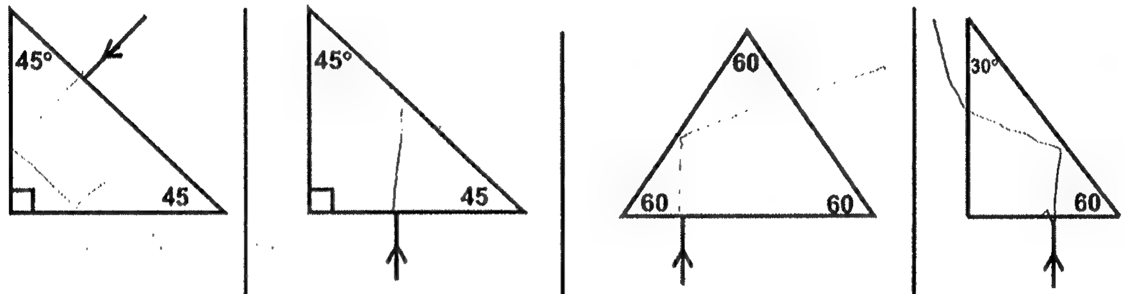
G.R. :

- The reflecting prism is preferred to metallic mirrors.
  Because in the reflecting prism the reflection is 100% also the metallic mirror may lose its lustre or its ability to reflect.

G.R.:

- The face upon which light falls on the reflecting prism may be covered with a thin layer of material of refractive index less than that of glass such as cryolite (AlF_3) or (MgF_2) .
  To minimize the losses (dissipation) in light intensity when entering or coming from the prism.

Trace the path of light ray and find angle of emergence (n = 1.5) .



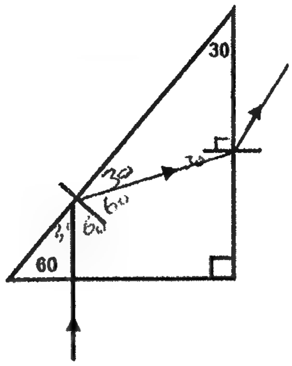
Trace the path of light ray :

$n = 1.5$
$\phi_c = 42$

$$n = \frac{\sin \phi_{air}}{\sin \theta_{medium}}$$

$$1.5 = \frac{\sin \phi_{air}}{\sin \theta_{30}}$$

angle emergence $= 48^\circ 35'$

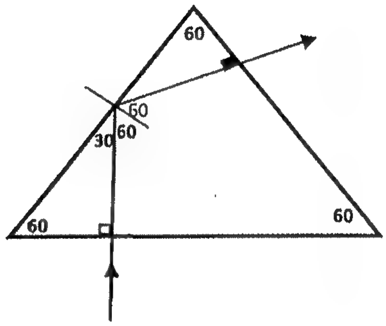


$\phi_c = 42$
angle emergence = zero

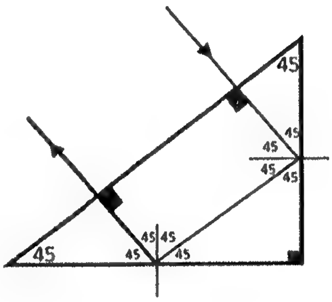
$$n = \frac{\sin \phi_{air}}{\sin \theta_{medium}}$$

$$1.5 = \frac{\sin \phi_{air}}{\sin 90}$$

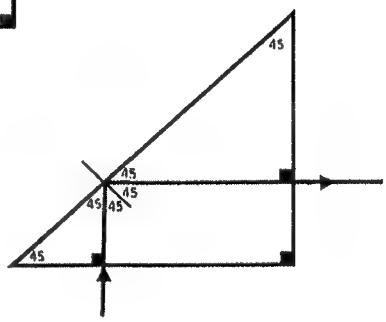
ϕ = zero



$\phi_c = 42$
angle emergence = zero



$\phi_c = 42$
angle emergence = zero



Mention the scientific idea for :

1- Optical fiber .
2- Reflecting prism .
3- Mirage .

Sol.

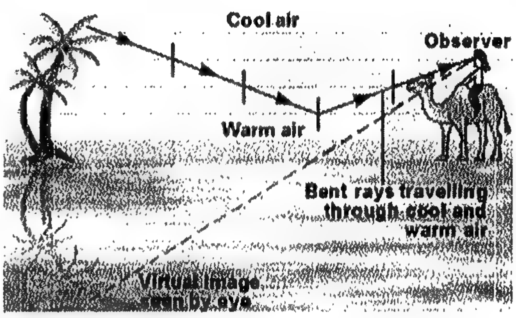
Critical angle and total internal reflection as $\phi > \phi_c$

Mention an application (use) :

1- Optical fiber transporting light energy without much loses , endoscopes .
2- Reflecting prism change path of light periscope in submarine binoculars .
3- Cryolpte to minimize the dissipates of light intensity when light entering or coming out from the prism .
4- Endoscope surgery operation with laser beam medical examination .

3- Mirage :

- It is a phenomenon produced due to total internal reflection in hot regions.
- Air nearer to the surface of the ground becomes hot so its density decrease.
- Light from the upper position of the object reaches the person by the two paths.



1) Ray comes directly to his eyes .
2) The ray which comes from the denser medium refracts away from the normal and its deviation increases till the angle of incidence from the denser layer to the less denser one is greater than the critical angle. Total reflection occurs and the eye sees the inverted image of the object at the extension of the reflected rays so it seems as if there is a pool of water .

Deviation with triangular prism

ϕ_1 the angle of incidence.

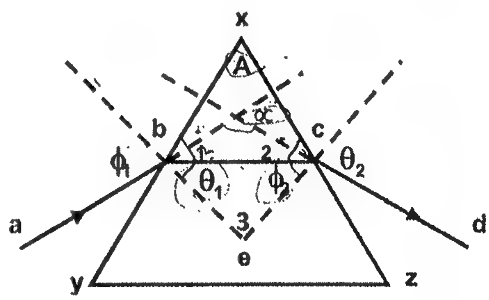
θ_1 angle of refraction at the first surface.

ϕ_2 angle of incidence at the second surface .

θ_2 the angle of emergence.

α angle of deviation.

A angle of prism (apex) (refractive angle)



Prove that $A = \theta_1 + \phi_2$

From the geometry of the fig.

$A + 3 = 180.$

$\theta_1 + \phi_2 + 3 = 180.$

$\boxed{A = \theta_1 + \phi_2}$

Fig xBec quad

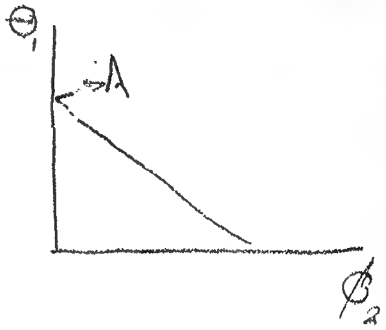
$A + \hat{3} = 180 \rightarrow (1)$

$\triangle Bec$

$\theta_1 + \phi_2 + \hat{3} = 180 \rightarrow (2)$

$A = \theta_1 + \phi_2$

Prove that $\alpha = \phi_1 + \theta_2 - A$



$\alpha = \hat{1} + \hat{2}$

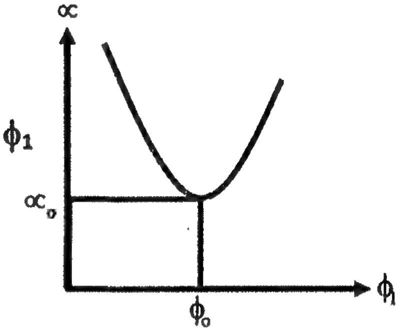
$\alpha = (\phi_1 - \theta_1) + (\theta_2 - \phi_2)$

$\alpha = \phi_1 - \theta_1 + \theta_2 - \phi_2$

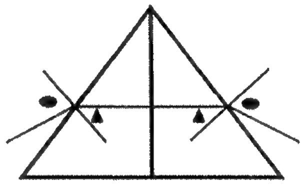
$\alpha = \phi_1 + \theta_2 - (\theta_1 + \phi_2)$

$\alpha = \phi_1 + \theta_2 - A$

$\therefore$ α depend on refractive angle (A) and angle of incidence ϕ_1



- it may be demonstrated practically that the angle of deviation decreases with an increase of the angle of incidence to minimum value then starts to increase again with increasing angle of incidence.
- The position at which (α) is minimum is called (minimum deviation).
- At minimum deviation
  $\phi_1 = \theta_2 = \phi_0$, $\theta_1 = \phi_2 = \theta_0$
- This state called symmetrical position.



Angle of deviation (α) : It is the acute angle inside the prism between the extensions of incident ray, and emergent ray.

- The law of minimum deviation

$\because \alpha = \phi_1 + \theta_2 - A$

$\because \phi_1 = \theta_2 = \phi_0$

$\therefore \alpha_0 = 2\phi_0 - A$

$\therefore \phi_0 = \left(\frac{\alpha_0 + A}{2}\right)$

$\therefore A = 2\theta_0$

$\therefore \theta_0 = A/2$

$\because n = \frac{\sin \varphi_0}{\sin \theta_0}$

$$\boxed{\therefore n = \frac{\sin\left(\frac{\alpha_0 + A}{2}\right)}{\sin\left(\frac{A}{2}\right)}}$$ At minimum deviation

Factors affecting α_0 :

(1) Refractive index of material of prism ($\alpha_0 \propto n$).

(2) The angle (A) ($\alpha_0 \propto {}^1/_A$) (A is constant for a certain prism)

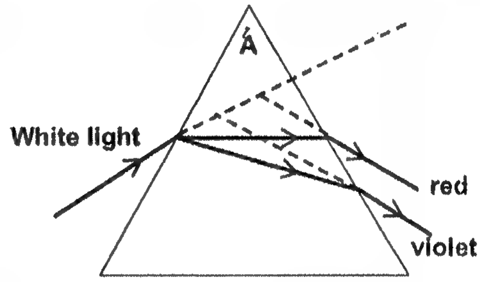
(3) Wavelength of falling light ($\alpha_0 \propto {}^1/_\lambda$)

$\alpha_0 = \phi_1 + \theta_2 - A$

The dispersion of light by triangular prism at minimum divination position .

- So when a beam of light falls on triangular prism adjusted in the minimum deviation position the emerged ray deviated into seven colored rays known as spectrum.
- The violet ray has the biggest deviation (maximum n) and the red ray has the least deviation (min n).

  $\alpha_0 \propto n \propto \frac{1}{\lambda}$



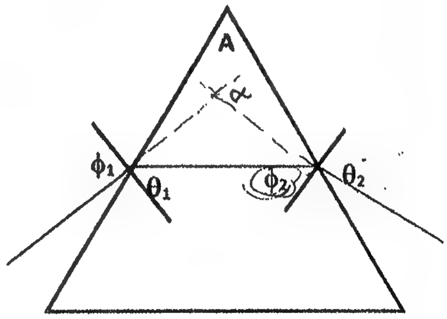
- The colors of spectrum of white light is red, orange , yellow , green, blue, indigo, and violet (ROYGBIV)
- **G.R.** : Triangular prism disperses white light into seven colours at minimum deviation position .
- Each colour has its own (λ , n) so it must have its own (α_0).

Laws triangular prism

1) $A = \theta_1 + \phi_2$

2) $\alpha = \phi_1 + \theta_2 - A$

3) $n = \dfrac{\sin \phi_1}{\sin \theta_1} = \dfrac{\sin \theta_2}{\sin \phi_2}$



sin الى بره
sin الى جوه

Notes

1) ray falls normal :

$\phi_1 = \theta_1 = \text{zero}$, $A = \phi_2$

مكان الدخول = 0

2) Ray emerges normal

$\phi_2 = \theta_2 = \text{zero}$, $A = \theta_1$

مكان الخروج = 0

3) ray emerges tangent (coincide) to surface (parallel)

$\theta_2 = 90°$, $\phi_2 = \phi_c$

4) Find smallest incident angle which makes the ray energy from the other side

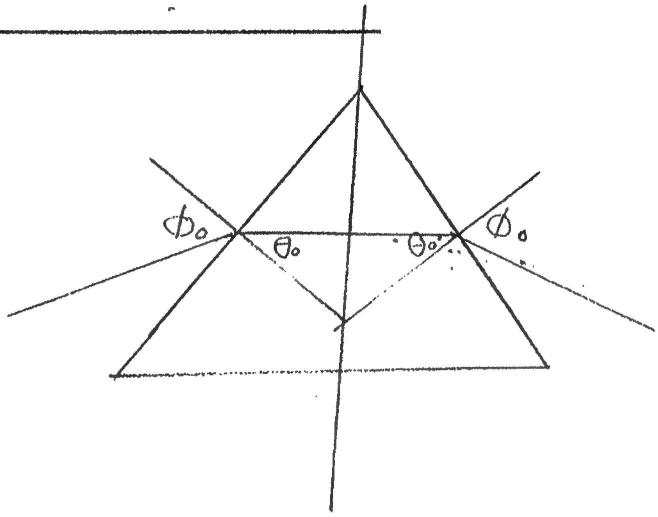
$\phi_1 = ??$, $\theta_2 = 90$, $\phi_2 = \phi_c$

- **Minimum divination positive :**
  1) $\phi_1 = \theta_2 = \phi_0$
  2) $\theta_1 = \phi_2 = \theta_0$

     $A = \theta_1 + \phi_2$

     $A = 2\,\theta_0$

     $\boxed{\theta_0 = A/2}$



$\alpha = \phi_1 + \theta_2 - A$

$\alpha_0 = 2\phi_0 - A$

$$\boxed{\phi_0 = \frac{\alpha_0 + A}{2}}$$

$$n = \frac{\sin \phi_0}{\sin \theta_0}$$

$$n = \frac{\sin\left(\frac{\alpha_0 + A}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

Thin prism : $A \le 10$

$\boxed{\alpha_0 = A(n-1)}$

α_0 depends on (n)

Tracing the path of a ray through a glass triangular prism and verification the laws of refraction Through the prism.

Equipment

- Equilateral triangular prism - protractor, pins and ruler.

Procedure:

(1) Place the glass prism on a sheet of drawing paper and mark its position .

(2) Fix two pins one of them close to one side and the other is about 10 cm from the first the line joining them (AB) represents incident ray .

(3) Look at the side of the prism to see the two pins behind each other and fix two other pins (C) and (D) so that they appear to be in line with the two pins (A) and (B) .

(4) Remove the pins and the prism join (B) and (C).

(5) Find the angle between the extensions of (AB) and (DC) (angle of deviation)

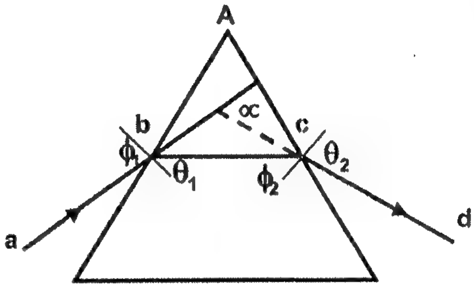
(6) Measure the angle $\phi_1, \theta_1, \phi_2, \theta_2$.

(7) Repeat the pervious steps several times by changing (ϕ_1) and tabulate the results.

From the results

$$\alpha = \phi_1 + \theta_2 - A$$

$$n = \frac{\sin(\frac{\alpha_0 + A}{2})}{\sin(\frac{A}{2})}$$



The Thin Prism

- A thin prism is a triangular prism having its angle (refractive angle (A) not more than a few degree: ($A \le 10$)
- It can be consider always in a position of minimum deviation. Why ?
  Bec. It disperses white light into seven color at any position .

$$n = \frac{\sin(\frac{\alpha_0 + A}{2})}{\sin(\frac{A}{2})}$$

ϕ and θ are small $\quad\quad$ $\sin\theta^0 = \theta^{red}$ (small angle)

So

$$\cancel{\sin}\frac{\alpha_0 + A}{2} = \frac{\alpha_0 + A}{2} \text{ (radian)}$$

$$\cancel{\sin}\frac{A}{2} = \frac{A}{2} \text{ (radian)}$$

$$n = \frac{(\frac{\alpha_0 + A}{2})}{(\frac{A}{2})}$$

$n = \frac{\alpha_0 + A}{A}$

$An = \alpha_0 + A$

$An - A = \alpha$

$A(n-1) = \alpha_0$

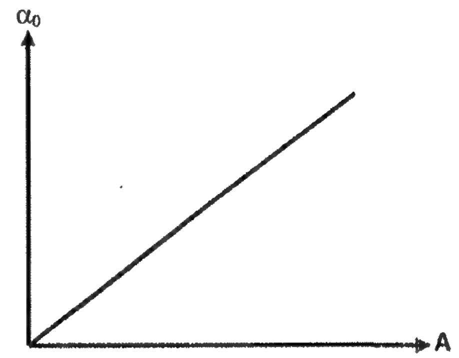
$$\alpha_0 = A(n-1)$$

So α_0 depends on refractive index of its substance .

Slope $= \frac{\alpha_0}{A}$

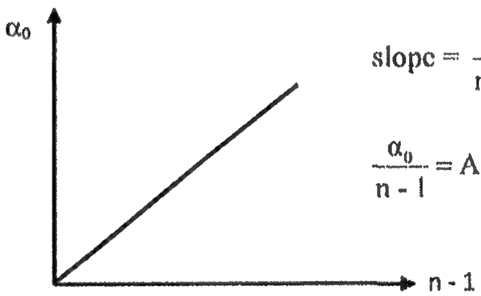
$\frac{\alpha_0}{A} = n - 1$

$\alpha_0 \propto A$



Slope $= \frac{\alpha_0}{(n-1)}$

$\frac{\alpha_0}{n-1} = A$



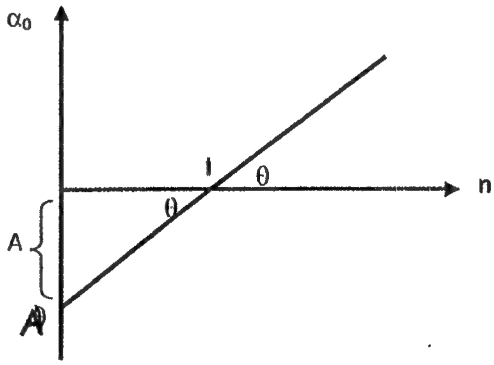
slope $= \frac{\alpha_0}{n-1}$

$\frac{\alpha_0}{n-1} = A$

$\alpha_0 = A(n-1)$

$\alpha_0 = An - A$

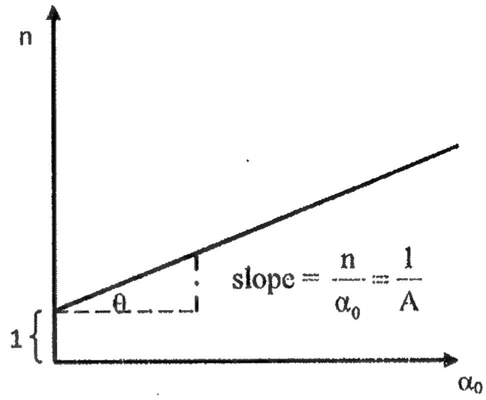
Slope $= \frac{\alpha_0}{n} = A$



$$\alpha_0 = A\,[\,n - 1\,]$$

$$\frac{\alpha_0}{A} = n - 1$$

$$n = \frac{\alpha_0}{A} + 1$$



Dispersive power

- When white light falls on a (thin) prism, the light-disperses into its spectrum due to the variation of the refractive index and wavelength.
- $(\alpha_0) = A\,(n_y - 1)$ mean deviation
- $(\alpha_0)_r = A\,(n_r - 1)$
- $(\alpha_0)_b = A\,(n_b - 1)$ subtracting
- $(\alpha_0)_b - (\alpha_0)_r = A\,(n_b - n_r)$
- The L . H .S is the Angular dispersion
- it is this angle between the red and blue light in the spectrum.
  Or It is the difference between angle of deviation of blue and that of red .

Note:-

- $(\alpha_0)_y$ is the average of $(\alpha_0)_r$ and $(\alpha_0)_b$.
- So (n_y) is the average of (n_r) and (n_b) .

Dispersive power (ω_α)

- It is the ratio between angular dispersion and mean deviation .

$$\omega_\alpha = \frac{(\alpha_0)_b - (\alpha_0)_r}{(\alpha_0)_y} = \frac{n_b - n_r}{n_y - 1}$$

Note :

$$(\alpha_0)_y = \frac{(\alpha_0)_b + (\alpha_0)_r}{2} \quad , \quad n_y = \frac{n_b + n_r}{2}$$

Questions Chapter (2) : Light as a wave

Essay questions

- Explain why light is considered to be a wave motion.

....
....
....

- Describe an experiment to demonstrate the interference of light.

....
....
....

- Explain how mirage is formed.

....
....
....

Define:

- The relative refractive index between two media.

....
....
....

- The absolute refractive index for a medium.

....
....
....

- The critical angle.

....
....
....

- The angle of deviation.

....
....
....

Complete:

- The distance between two successive bright fringes is given by ....
  ....
- Snell's law states that: ....
  ....
- The angle of deviation in a thin prism is given from relation: ....
  ....
- The dispersive power is: ....
  ....

Choose the right answer:

1) When light reflects:

- The angle of incidence is less than the angle of reflection.
- The angle of incidence is greater than the angle of reflection.
- The angle of incidence is equal to the angle of reflection.
- There is no right answer above.

- When light refracts, the ratio $\frac{\sin\phi}{\sin\theta}$,where ϕ is the angle of incidence and θ is the angle of refraction is:

a) constant for the two media. b) variable for the two media.
c) constant , greater than one. d) constant , less than one.

3) The ratio between the sine of the angle of incidence in the first medium to the sine of the angle of refraction in the second medium is known as:
   a) the absolute refractive index for the first medium.
   b) the absolute refractive index for the second medium.
   c) the relative refractive index from the second medium to the first medium.
   d) the relative refractive index from the first medium to the second medium.

4) The refractive index n_2 is equal to:
   a) $\frac{n_2}{n_1}$ b) $n = \frac{n_1}{n_2}$ c) $n_1 n_2$ d) $\frac{\sin\phi_2}{\sin\theta_1}$

5) The refractive index for the material of a prism in the minimum deviation position is:
   a) $n = \frac{\sin \alpha_0}{\sin A}$ b) $n = \frac{\sin\left(\frac{\alpha_0 + A}{2}\right)}{\sin\left(\frac{\alpha_0}{2}\right)}$ c) $n = \frac{\sin\left(\frac{\alpha_0 + A}{2}\right)}{\sin\left(\frac{A}{2}\right)}$ d) $n = \frac{\sin\left(\frac{\alpha_0 + A}{2}\right)}{\sin A}$

6) The minimum deviation angle in a thin prism is:

a) $\alpha_0 = n(A - 1)$ b) $\alpha_0 = A(n + 1)$

c) $\alpha_0 = n(A+1)$ d) $\alpha_0 = A(n - 1)$

7) The angle of incidence in a medium is 60° and the angle of refraction in the second medium is 30°. Then the relative refractive index from the first to the second medium is :

a) $\sqrt{3}$ b) $\sqrt{2}$ c) $\frac{1}{2}$ d) 2

8) An incident ray at an angle 48.5° on one of the faces of a glass rectangular block (n =1.5) , the angle of refraction is:

a) 20° b) 30° c) 35° d) 40°

9) In an experiment it was found that the minimum angle of deviation is 48.2° Given that the angle of the prism is 58.8°, the refractive index of the material of the prism is:

a) 1.5 b) 1.63 c) 1.85 d) $^1/_{1.85}$

10) If the critical angle for a medium to air is 45°, then the absolute refractive index is:

a) 1.64 b) 2 c) 1.7 d) $\sqrt{2}$

11) A thin prism has an angle of 5°. Its refractive index is 1.6. It produces a minimum angle of deviation equal to:

a) 5° b) 6° c) 8° d) 3°

12) A ray of light falls on a thin prism at an angle of deviation 4° and its apex angle 8°. Its refractive index is:

a) 1.5 b) 1.4 c) 1.33 d) 1.6

Questions for self – evaluation student's guide

1st : Multiple choice questions:

1- A thin prism of refractive index 1.5 and angle 4°, the angle of deviation equals:

a) 4° b) 3° c) 2° d) 1°

2- The angle of thin prism is 6 and the angle of deviation is 3 of an incident ray, the refractive index of such prism is:

a) 1.8 b) 1.7 c) 1.6 d) 1.5

3- A light ray falls on the interface between two media at an angle of incidence of 60°. It refracts by an angle 45°. The relative refractive index between the first medium and second medium is:

a) 2.44 b) 1.7 c) 1.22 d) 1.5

4- A light ray transfers from a medium to air. If the critical angle is 30°. So the absolute refractive index of such medium equals:

a) $\frac{\sqrt{3}}{2}$ b) $\frac{1}{2}$ c) 2 d) $\frac{1}{\sqrt{2}}$

5- Knowing that absolute refractive index of benzene is 1.5 and relative refractive index of the flint glass (1.65), then the relative refractive index between benzene and flint glass equals:

$\frac{1.65}{1.5}$

a) 0.91 b) 1.1 c) 1.25 d) 1.5

6- The relative refractive index between flint glass and benzene $_gn_b$ (According to the information given in the previous question) equals:

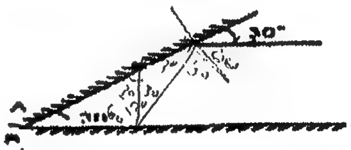
$\frac{1.5}{1.65}$

a) 1.65 b) 1.5 c) 1.1 d) 0.91

7- When a ray of light falls with an angle of incidence on a glass rectangle 60. If the absolute refractive index of glass = $\sqrt{3}$ then the angel of reflection equals:

a) 90° b) 60° c) 30° d) 45°

8- When a ray of light falls on the mirror A in a direction parallel to mirror B (as shown in figure) the reflected ray falls on the mirror B with an angel of incidence equals to:

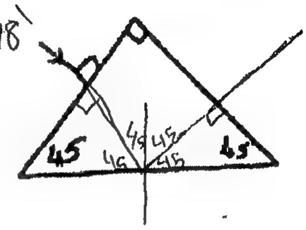


a) 90° b) 60° c) 30° d) 0°

9- In the previous figure the reflected beam on the mirror B fall once more on the mirror A with an angel of incidence equals to:

a) 60° b) 45° c) 30° d) 0°

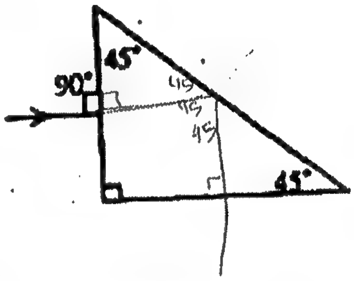
10- If the ray of the light falls normally on one face of a triangular prism of refractive index = 1.5. It emerges from the prism within emergence angel equals to:



a) 90° b) 60°

c) 0° d) 30°

11- If a ray of light falls normally on one side of a glass triangle prism (45° - 90° - 45°) as shown in the figure and if the refractive index of the prism is 1.5 the incident ray on the face corresponding to the right angle inside the prism will be:



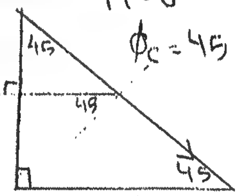
a) Emerge with an angle 45° b) Emerge with an angle 60°

c) Emerge with an angle 90° d) be totally reflected

12- In the previous figure of the refractive index of the prism is 1.414 the incident ray on the face corresponding to the right angel will:

$n = \sqrt{2}$

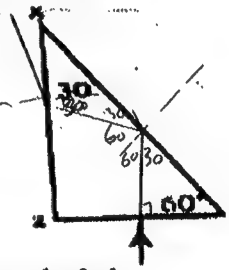
$\phi_c = 45$

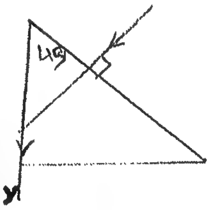


a) be totally reflected b) Emerge with an angle 60°

c) Emerge with an angle 82° d) Emerge tangent to this face

13- A narrow parallel beam of light meets normal incidence. The angles of the prism being as marked in the diagram. If the critical angle of glass 42°, which of the following statements is not true?





a) The beam cross the air – glass boundary YZ without deviation.

b) The angle of incidence at the face XY is 60

c) The beam undergoes total internal reflection at the face XY

d) A beam emerges from the face XZ

e) The beam undergoes total internal reflection at the face XZ

$n = \frac{\sin x}{\sin 30}$

$1.5 = \frac{\sin x}{\sin 30}$

$\sin x = 0.75$

$x = 48°35'25.36''$

14- In one medium a wave has a frequency f_1 wavelength λ_1 and speed c_1 the wave passes from this medium into another, where its speed $\frac{2}{3}c_1$. In the second medium the:

a) Frequency is still f_1 and the wavelength is stell λ_1

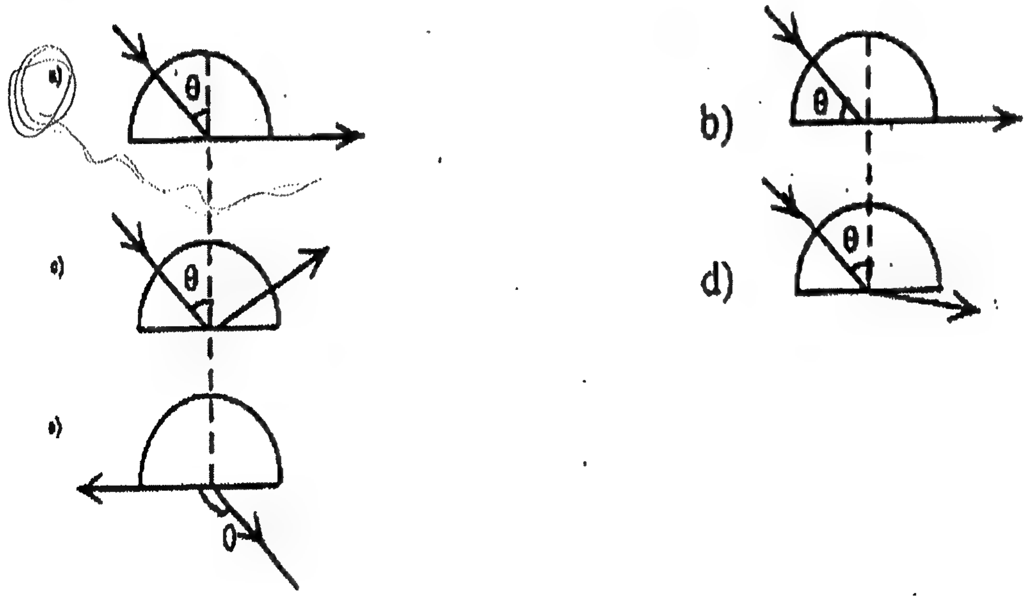
b) Frequency is still f_1 and the wavelength is $\frac{2}{3}\lambda_1$

c) Frequency is still f_1 and the wavelength is stell $\frac{3}{2}\lambda_1$

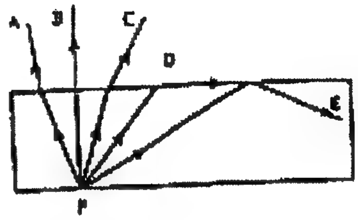
d) Wavelength is still λ_1 but the frequency is $\frac{3}{2}f_1$

e) Wavelength is still λ_1 but the frequency is $\frac{2}{3}f_1$

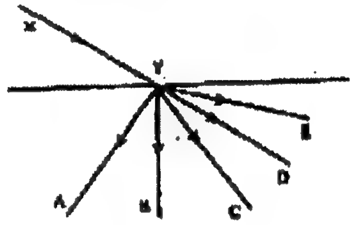
15- A student was asked to find the critical angle for glass by plotting rays of light through a semicircular glass block. Which of the diagrams below correctly shows the critical angle, marked as θ



16- A glass block shown rests on a small spot of luminous point, P, five rays of light from P are labled A, B, C, D and E. Which of the rays cannot possibly follow the path shown? (A)



17- Light from X strikes a glass surface at Y. Which of the paths A, B, C, D or E is the light most likely to allow after catering the glass? (C)



18- The diagram shows a narrow, parallel beam of lights incident at 42 on a rectangular glass block of refractive index 1.5.

1. After entering face WX, the light energy will:

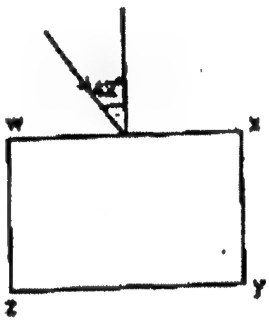
a) Be absorbed in the block

b) Be internally reflected at face ZY

c) Leave the block through face ZY

d) Leave the block through face XY

e) Leave the block face WZ



2. The angle of reflection in the block is given by:

a) $\frac{42°}{1.5}$　　b) $42° \times 1.5$　　c) $\sin\frac{42°}{1.5}$

d) The angle whose sin is $\frac{\sin 42°}{1.5}$

e) The angle whose sign is $\frac{1.5}{\sin 42°}$

19- The image formed by an object in a plane mirror can never be:

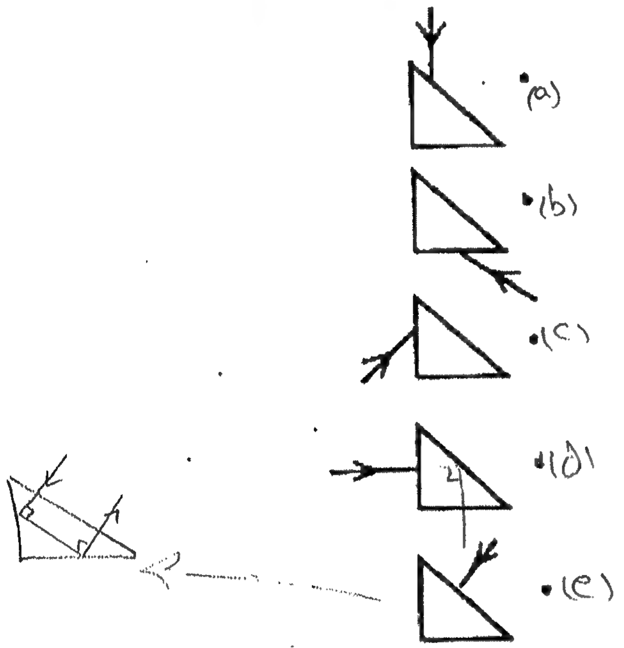
a) real　　b) erect

c) The same size as the object　　d) Laterally inverted

e) As for behind the mirror as the object in front of it

Group two:

(•) **The following figure represent five different ways of directing a narrow parallel beam of white light on to a (45° - 90° - 45°) triangular glass prism.**



Which would you use to:

1. deviate the beam through 90° (d)
2. make the beam emerge from the face which is entered initially (e)
3. make the beam undergo internal reflection twice (e)

2nd : Essay question:

1- Give reasons for the following: $n = \frac{c}{v}$ $c > v$. (c اكبر من ال v)

a) The absolute refractive index of light for any medium is greater than unity.

b) The reflecting prism is preferred to plane reflecting mirror in some optical instruments reflected light with 100%

mirror loses its luster

$\lambda = \frac{\Delta y\, d}{R}$

c) In young's double slit experiment the interference becomes more clearly as the distance between the two slits decreases $\Delta y = \frac{\lambda R}{d}$ $\Delta y \propto R$ $\Delta y \propto \frac{1}{d}$

d) The prism disperses white light to its seven colors
each color has its own (λ, n) so it must have its own α.

e) The relative refractive index between two media may be less than unity
$V_2 > V_1$

f) The optical fibers are used to see places which cannot be seen easily

g) The occurrence of mirage in deserts Total internal reflection as $\phi > \phi_c$

i) As the light ray passes through a narrow double slit, there are interference fringes (bright and dark) on a white screen placed at a suitable distance. due to superposition of two cherent waves

j) The red color has the minimum deviatin while the violet light has maximum deviation in the prism red has smallest n and largest λ
violet has largest n and smallest λ

2- What is meant by ?

a) The absolute refractive index of water = 4/3

b) The absolute refractive index of glass = 3/2

c) The relative refractive index from water to glass = 9/8

d) Angular dispersion in thin prism = 0.2

e) The dispersive power in triangular prism = 0.02

f) The angle of deviation in tringular prism = 30

g) The critical angle between glass and air = 42° 42° is the angle of the incident in glass that corresponting to angle of reflection in air = 90

3- What is different between the critical angle and the angle of deviation in prism?

4- What is meant by optical fibers? And what are their applications?

5- Explain by drawing the passage of light within the optical fibers?

6- Explain young's double slit experiment, how can you detrermine the distance between two similar fringes?

7- Explain why light is dispersed in the prism?

8- Show how the mirage in deserts occurs.

9- Prove the following laws for triangular prism

$$A = \theta_1 + \phi_1, \quad \alpha = (\phi_1 + \theta_2) - A$$

10- Mention what do you know about the totally reflecting prism?

11- Trace the path of a light ray incident on a triangular prism with acute angle.

12- Show with drawing what happens to light ray incident on a right angle prism with the sides of the right angle equal, in the following cases (the critical angel between the prism and air = 42°).

a) The incident angle of the light ray equals zero on one side of the right angle.

b) The incident ray is normal to the side corresponding to the right angle. Follow the ray until emerges from the prism

13- Prove that the deviation angle in the thin triangular prism can be determined from the relation: $\alpha_0 = A(n - 1)$.

14- Find the relation which we can use to calculate the despressive power.

15- What is the function of each of the following:

a) Reflecting layer in the reflecting prism

b) The reflecting prism

c) The double slit in the young's experiment

16- You have a glass equilateral triangular prism. Expalin how you can trace the path of a light ray inside the prism experimentally. Show on your drawing the angle of the prism, the angel of the incidence, the angle of the emergence and the angle of deviation. Write down the mathematical relation between these angles.

17- Mention one use only for each of the following:

a) The right angled prism

b) The equilateral triangular prism

c) The thin prism

d) The optical fibers

3rd : Problems:

1- If the refractive indices of water and glass are 1.4 and 1.6 respectively, the velocity of light in air (space) is 3×10^8 m/sec. Calculate:

a) The velocity of light in glass

b) The critical angle for water relative to air.

c) The relative refractive index between glass and water

2- A light ray falls in the interface between water and air by an angle 45°. Determine the direction of the reflecting and refracting rays, knowing that the refractive index of water = 1.4.

3- A light ray falls on a triangular prism by an angle 60°. It emerges by an angle 30°. If the refractive index of such prism is 1.6; find the refractive angle of the prism.

4- A light ray falls normal to one side of a prism and emerges tangent to the other side. If the refractive index of such index is $\sqrt{2}$; find the refractive angle of the prism.

5- A thin prism of angle 10° and of refractive incidence 1.51 for red and 1.53 for blue colors calculate:

$A = 10^\circ$ $n_r = 1.51$ $n_b = 1.53$

$\alpha_b = A(n_b - 1) = 10(1.53-1) = 5.3^\circ$

$\alpha_r = A(n_r - 1) = 10(1.51-1) = 5.1^\circ$

a) The angle of deviation for both red and blue colors

b) The despersive angular size of such prism $\alpha_b - \alpha_r = 5.3 - 5.1 = 0.2^\circ$

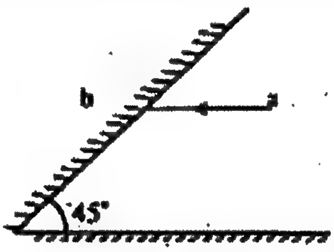
c) The despersive power of such prism $\alpha_y = \frac{\alpha_b + \alpha_r}{2} = \frac{5.3 + 5.1}{2} = 5.2$ $\omega_\alpha = \frac{\alpha_b - \alpha_r}{\alpha_y} = \frac{1}{26}$

6- A light ray falls normal to one side of tringular prism of equal sides, it emerges tangent to the other side, determine the refractive index of the prism.

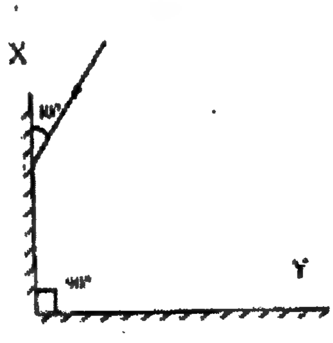
7- A ray falls on a prism whose angle is 45°, the angle of incidence is 60, the ray emerges normal to the other side of the prism, find the refractive index of the prism. α

8- If the angle of minimum deviation is 30° for a triangular prism whose sides are equal for a ray; find the refractive index of the prism, incidence angle and emergent angle of the ray in this case.

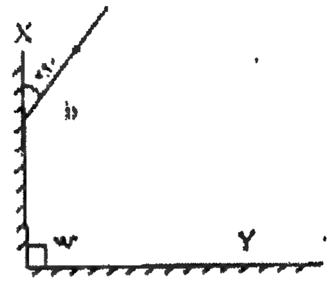
9- Two mirrors x and y are fixed such that angle between their reflecting surface is 45°. A light ray ab is incident on x, finds the angle of the incidence of the ray reflected from x and is incident on y, with drawing. Determine the direction of the reflected ray at the mirror y, comment on the final result.



10- As shown in the figure; A ray ab falls on a mirror (x). Find the angle of reflection at the mirror (y) completes the drawing. Determine the direction of the reflected ray at the mirror Y, comment on the final result.



11- A ray falls on a mirror (x) as shown in the figure find the angle of reflection at the mirror (y) complete the drawing. Determine the direction of the reflected ray at the mirror y, comment on the final result.



12- Using a monochromatic light in young's double slit experiment if the distance separating the two slits is 1 mm and the distance between the double slits and the screen is 1 m and the distance between the successive illuminated fringes is 0.5 mm. Calculate the wavelength of the light used. $\lambda = \frac{\Delta y\, d}{R} = \frac{0.5\times10^{-3}\times1\times10^{-3}}{1} = 5\times10^{-7}$

13- Calculate the frequency of the used light in young's experiment, if the distance separating the two slits is 0.00015 m and the distance between the double slits and the screen is 0.75 m and the distance between two successive illuminated fringes is 0.002 m. Give illuminated the velocity of light = 3×10^{8} m/sec.

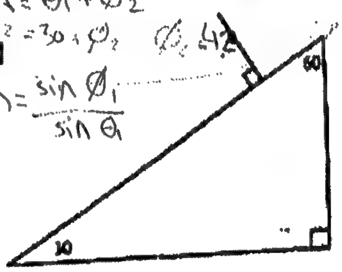
14- A light ray falls from air on one face of a triangular prism whose angle is 72°. It is refacted by an angle 30° and emerges tangentially to the other face. Find:

a) The critical angle between glass and air $A = \theta_1 + \phi_2$, $72 = 30 + \phi_2$, $\phi_2 = 42$

b) The refractive index of the prism material $n = \frac{1}{\sin\phi_c} = \frac{1}{\sin 42} = 1.49$

c) The sine of the first angle of incidence. $n = \frac{\sin\phi_1}{\sin\theta_1}$, $1.49 = \frac{\sin\phi_1}{\sin 30}$, $\sin\phi = 0.74$

15- A light ray is incident perpendicular to one side of a triangular prism of refractive index 1.5 as shown in fig. Trace the path of the light ray inside the prism, then find its angle of emergence from the prism.



16- In a young's double slit experiment, the fringe separation observed using green light was found to be 0.275 mm the green lamp, giving a wavelength of 550nm, the lamp is replaced by another one giving wavelength 400 nm in the violet and 600 nm in the red the remainder of the apparatus is undisturbed. Calculate:

a) The distance between the fringes formed by the violet light.

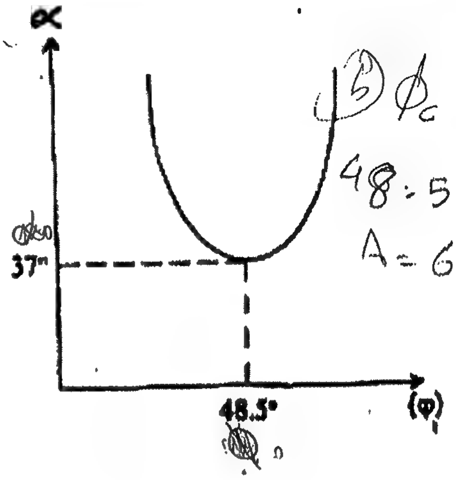
b) The distance between the fringes formed by the red light

17- The opposite figure represents the relation between the incident angle ϕ_1 and the angle of deviation α of light ray falling on one face of the triangular prism. Using the values shown in the fig. To calculate:

a) The emergence angle of the ray $48.5°$

b) The refractive angle of the prism

c) The refractive index of the prism

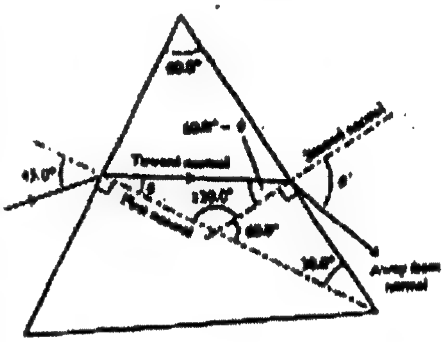


(3) $\phi_o = \frac{\alpha_o + A}{2}$

$48.5 = \frac{37 + A}{2}$

$A = 60.$

18- The refractive index of a certain glass has a value of 1.67 for blue light of wavelength 450 nm and a value of 1.64 for red light of wavelength 700 nm. An equilateral prism is made from this glass, and a beam of white light is incident on a face of the prism at an angle of 45°. Find the angles at which blue light and red emerge from the opposite side of the prism.



4- Miscellaneous Questions:

1- Find the critical angle for light traveling from water (n=1.333) into ice (n=1.309).

2- Which of the following describe places where a mirage is likely to appear ?

a) above a warm lake on a warmday

b) above an asphalt road on a hot day

c) above the slope on a cold day

d) above the sand on a beach on a hot day

e) above a black car on a sunny day

3- When white light passes through a prism which will be bent more, the red or green light?

4- After a storm, a man walks out onto his porch. Looking to the east, he sees a rainbow that has formed above his neighbor's house. What time of day is it, morning or evening?

Unit 2 : fluid mechanics properties of matter

Chapter (4) : Characteristics of Liquids In Motion

There are two kinds of flow:

(I) Turbulent flow.

(II) Steady flow.

(I) Turbulent flow

It occurs when-the velocity of liquid flow exceeds a definite limited value it is characterized by small eddy circles. (vortices)

(II) Steady flow. (laminar flow) (stream line flow)

- It occurs when the fluid moves such that its neighboring layers slide in smooth and ease.
- It is characterized by the fact that each particle of the fluid follows a smooth path called stream line.

Stream line:

It is the path which is followed by a particle of the fluid.

Properties of streamlines:

1. They do not intersect (parallel).
2. The tangent at any point of a stream line gives the direction of the instantaneous velocity.
3. They come closer together when the speed of the liquid is high and far a part when the speed is low.

Conditions of stream line flow (steady flow)

1. The liquid fills the tube completely.
2. The quantity of the liquid entering the tube equal the quantity of liquid coming out from the other end in the same time.
3. The velocity of fluid flow at any point in the tube does not change with time.
4. Irrotational (No vortices)
5. The rate of flow is constant along its path.
6. If there is no friction between layers of liquid the flow is non viscous .

The volume flow rate of a liquid $(Q)_V$

The volume of the fluid flowing through a certain area per unit time =Av

A = area, v = distance covered by the fluid per unit time.

∴ The volume flow rate = $A.v = Q_v$

- The volume flow rate in time:

  (T) second = $Q_v \times T = V_{ol}$

  $V_{ol} = Q_vT = AvT$.

* Mass flow rate (Q_m)

It is the mass of the flowing fluid through a certain area per unit time.

[the volume of the fluid flowing per unit time X ρ density of fluid]

$Q_m = Q_v \times \rho = Av\rho$

The mass of the fluid flowing through a time (T) $M' = Av\rho T$.

What is meant by:

1. The flow rate of a liquid = 10^{-3} m^3/sec .

   The volume of the liquid flowing a certain area per unit time = 10^{-3} m^3.

2. Flow rate of a liquid = 2 kg/sec .

   the mass of the liquid flowing a certain area per unit time = 2kg.

Density of stream lines [The rate of flow of a liquid at a point] It is measured by the number of stream lines passing perpendicular through a unit area at that point.

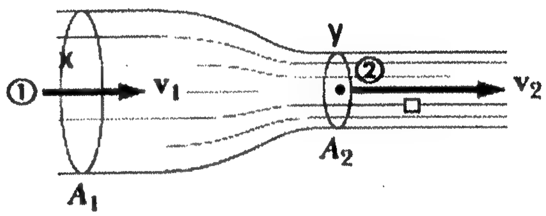
Equation of Continuity

- A_1 and A_2 are two areas $\perp$ to the stream lines at points (a,b).
- V_1 is the velocity of liquid at (a) and V_2 is its velocity at (b).

at (x)

$Q_v = A_1 v_1$

Mass flow rate $(Q_m) = A_1 v_1 \rho$



at (y)

$Q_v = A_2 v_2$.

Mass flow rate $(Q_m) = A_2 v_2 \rho$

$\because$ the rate of flow is constant [steady flow]

$A_1 v_1 \rho = A_2 v_2 \rho$

$A_1 v_1 = A_2 v_2$

Conclusions:

- The velocity of the liquid at any point in the tube- is. inversely proportional with the cross section of the tube. (continuity Equation)

$v \alpha \frac{1}{A}$, $v \alpha \frac{1}{r^2}$

N.B. $\frac{v_2}{v_1} = \frac{A_1}{A_2} = \frac{R_1^2}{R_2^2} = \frac{D_1^2}{D_2^2}$

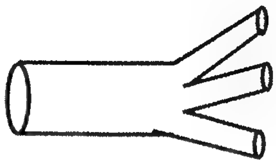
* V at any point is directly proportional with (the number of stream lines. Passing normally through unit area surrounding this point) .

(- Density of stream lines) (- Density of flow)

Notes for solving problems:

1. $\frac{v_2}{v_1} = \frac{A_1}{A_2} = \frac{R_1^2}{R_2^2} = \frac{D_1^2}{D_2^2}$

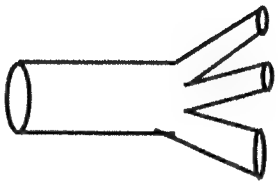
   Or $A_1V_1 = A_2V_2$



2. $A_1v_1 = N\ A_2v_2$

   N : Number of Equal Branches

3. $A_1v_1 = A_2v_2 + A_3v_3 + A_4v_4 + ...$



G.R

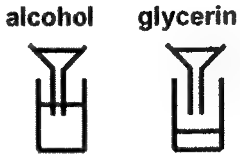
1. The cross sectional area of the total capillaries is greater than that of the aorta so blood flows in the capillaries with slow velocity according to continvity equation [$V \alpha \frac{1}{A}$] to allow the exchange of gases and food between blood and the cells.
2. The pipes of firemen have pointed ends
   to increase the speed of ejected water so water can reach far distance.
   According to continuity equation [$V \alpha \frac{1}{A}$]

Viscosity

It is the property which is responsible for resisting the liquid layers motion and resisting the motion of bodies through fluid due to friction between them.

Exp:

Prepare the fig



Obs:

The stream velocity:

Of alcohol is higher than that of glycerin.

Exp:

Stirring the liquids.

Obs:

The rod moves in water more easier than in honey. Water resistance to the motion of glass rod is less than honey resistance.

Exp:

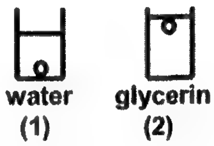
When you taking off rods.

Obs:

The motion of honey stops through a very short period of time.

Exp:

Prepare the fig



Obs:

The time taken by the metallic ball to arrive the bottom of measuring cylinder in (1) is less than in (2).

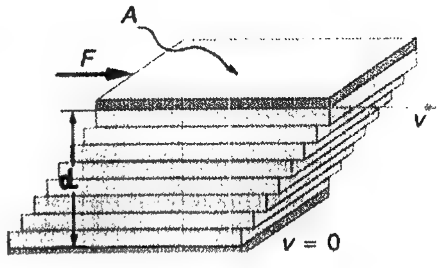
Accordingly we can conclude the following:

1. The ability of some liquids as H_2O and Alcohol to flow is large and its resistance to body motion is small.

2. Other liquids as honey and glycerin have low ability to flow and they have high resistance to body motion.

Explanation of concept of viscosity

1. Let us imagine a layer of a fluid confined between two parallel plates one of them at rest and the other moves with velocity (V).



2. Let the fluid consists of thin layers. The velocity of the lower layer in contact with the fixed plate is zero while that of the upper layer which in contact with the moving plates is (V). the velocity of liquid layers increases from zero to v as we move up this is attributed.
   a. The frictional force between the lower plate and the liquid layer in contact with it due to adhesive forces. This leads to a zero velocity of the layer in contact with the rest plate. Due to the same reason the upper layer moves with the same velocity of the upper plate.
   b. There is a force similar to frictional force between two different layers of liq. Producing relative change in velocity between any two adjacent layers.

Coefficient of Viscosity

From the previous (fig) we find that in order to keep the plate moving with constant velocity (v) a force (F) is required which depends on:

1. The area of moving plate (A) ($F \alpha A$).
2. The velocity of the moving layer ($F \alpha v$)
3. The distance (d) Between the two plates $F \alpha \frac{1}{d}$

$$F \alpha \frac{Av}{d}$$

$$F = \eta_{vs} \frac{Av}{d}$$

Where η (إيتا) is the coefficient of viscosity

$$\eta_{vs} = \frac{F.d}{Av}$$

unit $N.S/m^2 = kgm^{-1}S^{-1}$ = Pascal. S.

*D.F.:$ML^{-1}T^{-1}$

The Coefficient of Viscosity:

It is the tangential force acting on unit area to produce change in velocity of 1 m/s between two liquid layers the normal distance between them is 1 m.

What is meant by: $\eta_{vs} = 3 \times 10^{-3}$ kg $m^{-1}S^{-1}$?

....

....

Applications of the viscosity

(I) Lubrication:

G.R. (1) **Machines must be lubricated from time to time using oil of high viscosity and high adhesive forces.**

1. To reduce the quantity of heat generated by friction.

2. Protecting the machine parts from wearing out.

(2) **Water can not be used in lubrication.**

Because it has small adhesive forces so it will flow rapidly from the machine during motion also it has low viscosity and evaporate easily .

Low viscosity

(II) Reducing the consumption of fuel in moving cars :

1- In case of relatively small or intermediate speeds the air resistance affecting the moving bodies (as a result of air viscosity) is directly proportional to the velocity of the moving bodies.

2- When the speed of car increases than a certain value. The air resistance is proportional to the square of the velocity so the consumption of fuel increases with increasing the velocity-more than this limit (air resistance α v^2)

3- G.R.: The expert driver should decrease the velocity to economize the fuel consumption.

$R_{\text{air due to viscosity}} \ \alpha$ → V small and inter mediate speed
→ V^2 high speed

(III) Sedimentation rate test in medicine :

1. The final speed of falling red blood corpuscles through plasma is directly proportional with r^2 where (r) is the radius of blood corpuscles

$$v \ \alpha \ r^2$$

2. Doctors know if the volume of red corpuscles is normal or not through the measurement of sedimentation rate.
3. In some diseases like rheumatic fever rheumatic heart and gout the red blood corpuscles adhere so their volume increases and the sedimentation rate increases.
4. In case of anemia the red corpuscles are broken so their volume decreases and the sedimentation rate decreases below its normal level.
5. When the R.B.C_S falls through the plasma they are affected by three forces:

a. its weight (acts downwards) ↓

b. F_b (buoyant force) (acts upward) ↑

c. friction force with the plasma due to viscosity ↑

from the resultant force it is found that the final speed of falling R.B.G_S increases with the increasing radius.

Unit 2 : fluid mechanics properties of matter

Questions Chapter (4) : Characteristics of Liquids In Motion

Define

1) fluid

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2) viscosity

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3) coefficient of viscosity

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Essay questions

1) Prove that the velocity of a liquid at any point in a tube is inversely proportional to , the cross sectional area of the tube at that point.

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2) Explain the property of viscosity.

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3) Illustrate some applications of viscosity.

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Problems :

1- Water flows in a horizontal hose at a rate of 0.002 m^3/s, calculate the velocity of the water in a pipe of cross sectional area 1cm^2. (20 m/s)

2- Water flows in a rubber hose of diameter 1.2cm with velocity 3m/s. Calculate the diameter of the hose if the velocity of the emerging water is 27m/s. (0.4cm)

3- A main artery of radius 0.035 cm branches out to 80 capillaries of radius 0.1mm. if the velocity of blood through the artery is 0.044 m/s ,what is the velocity of blood in each of the capillaries? (0.0067m/s)

4- The cross sectional area of a tube at point A is 10 cm^2 and at point B is 2cm^2, e velocity of water at A is 12 m/s, what is the velocity at B ? (60m/s)

5- The cross sectional area of a water pipe at the ground floor is $4 \times 10^{4} m^2$ The velocity of the water is 2 m/s. When the pipe tapers to a cross sectional area of $2 \times 10^{-4} m^2$ at the end, calculate the velocity of the flow of water at the upper floor. (4m/s)

ElAzhar93:

What are the conditions of steady flow?

ElAzhar94:

G.R.: Presence of narrow constriction at the ends of the pipes used by firemen.

Egypt 97:

G.R.: in the steady flow the liq will flow very slowly when the cross sectional area is large and. quickly if it is small.

Examinations Problems

* Egypt89 :

Water flows in a pipe of diameter 2 cm at an average speed 10 m/s what is the rate of flow in m^3/min? then find the required time to fill a tank of volume 20 m^3 completely with water. ($Q_v = 3.14\times10^{-3} m^3/s$, V= 0.188 m^3 10^6min)

*Egypt 92:

A tube provides a field with water its cross sectional area is 4 cm^2 the velocity of water is 10m/s, the end of the tube is closed and contains 100 holes each of area l mm^2 find the velocity of flow from every hole .

- ELAzharI992:

Prove that the velocity of flow of a fluid at any point in the tube is inversely proportional to the cross sectional area of the tube at that point.

Egypt 93:

A water pipe entering a home. Its diameter is 1.5 cm and the speed of water is 0.2 m/s eventually the diameter becomes 0.5 cm. Find:

1. The speed of water at narrow position (V = 1.8) .
2. The amount of water that flows per min across the tube.

Questions for the self – evaluation student's guide

First: Multiple choice questions: [Dynamic Fluid]

Group One:

Select the most correct answer:

1- The velocity of fluid is inversely proportional to the cross – sectional area of the tube through which it flows. This statement relates to:

a) The rate of flow of liquid

b) Pascal's principle

c) The continuity equation

d) Archimedes's principle

2- The tangential force acting on a unit of a liquid surface and producing a unit change in velocity of two liquid layers at a unit normal distant a part from each other, this expresses:

a) The pressure

b) The Pascal's principle

c) The coefficient of viscosity

d) Archimedes's principle

3- The number of streamlines of a liquid passing normal to unit area surrounding point is:

a) Continuity equation   e) density of streamlines

b) Liquid rate of mass flow

c) The principle stream lines

d) The velocity of flow at the point

4- The unit of the coefficient of viscosity of a liquid is:

a) $Kg.\, m\, S^{-1}$ b) $Kg\, .m^{-1}S^{-1}$ c) $Kg\, .m^{-2}S$ d) $Kg.m^{2}S^{-1}$

5- (Pascal . Second) is equivalent to the unit of:

a) The pressure   b) Rate if liquid flow

c) The liquid rate of mass of flow

d) The coefficient of viscosity of liquid

6- (Newton . Second. m^{-2}) is the equivalent to the unit of:

a) The pressure b) The Rate of flow of liquid

c) The coefficient of viscosity of liquid

d) The liquid rate of mass of flow

7- At higher velocities of a car, the air resistance due to its velocity is directly proportional to:

a) The velocity of the car

b) 1 / the velocity of the car

c) The square of the velocity of the car

d) 1 / square of the velocity of the car

8- The liquid resistance to the motion of bodies in it is:

a) Density of liquid b) Viscosity

c) The pressure inside a liquid d) The transfer of liquids

9- Oil used for lubricating the movable parts of a machine has:

a) High ability of flow

b) Moderate ability of flow

c) Low ability of flow

d) Very low viscosity

10- The unit of measuring the liquid mass flowing through the tube per unit time:

a) m^3/s b) Kg c) Kg/s d) m^3

11- If the velocity of water in a tube of internal diameter 1.4cm is 4 m/s, the rate of the water flow is:

a) $6.16 \times 10^{-6}\ m^3/s$ b) $6.16 \times 10^{-4}\ m^3/s$

c) $6.16 \times 10^{-5}\ m^3/s$ d) $0.0068\ m^3/s$

Group Two:

The questions in this section are classified in group. Each group consists of five statement (a, b, c, d and e) followed by a list if questions. Select the most

suitable statement as an answer for each question. Each statement may be used once or more or not to be used at all.

Question 1 – 3:

There are five physical quantities:

a) Cubic meter per second

b) Kg / second

c) N / m^2

d) $Joule / m^2$

e) $Kg^{-1}S^{-1}m^{-1}$

Which of these quantities is used as a unit of?

1. The coefficient of viscosity of a liquid
2. The rate of mass flow of a liquid
3. The volume of a liquid flows per unit time

Second: Essay questions:.

1- what is meant by each of the following

1) The rate of volume flow

2) The rate of mass flow

3)The coefficient of viscosity of a liquid

4) The viscosity

5) The steady flow

6) The turbulent flow

2-Given reasons of each of the following:

1) Oils of high viscosity are used in lubricating the moving metallic parts of the machines.

2) It is possible for a doctor to diagnose some diseases through out the measurement of the blood sedimentation rate.

3) The well expert driver do not increase the car speed more than a certain limit to economize the fuel consumption.
4) From God gifts the total cross – sectional area of the blood capillaries is larger than the cross – sectional area of the major artery.
5) When the viscosity of a fluid increases, its resistance to a solid body motion through it increases.
6) The sedimentation (precipitation) rate of blood in case of rheumatic fever increases while in case of anemia it decreases.
7) The momentum of a body moving in a fluid decreases
8) Water cannot be used as a lubricant material

3-write the scientific term for each of the following:

1) The tangential force acting on unit area to produce a unit change in velocity between two liquid layers at unit distance apart from each other
2) The rate of volume flow of a liquid
3) The rate of mass flow of a liquid
4) The velocity of a fluid at a point is inversely proportional to the cross sectional area at this point $V \propto 1/A$
5) It is the property that the fluid resists the movement of its layers It prevents the sliding of layer above each other.

Third: Miscellaneous questions:

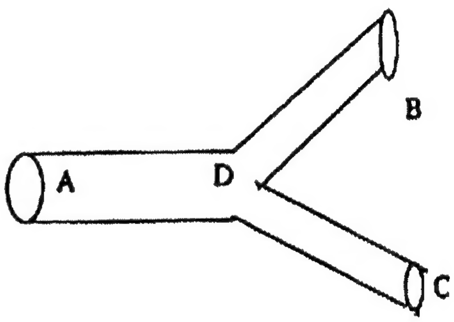
1. **What does this mean?** the coefficient of viscosity of a liquid = 0.04 $N.s.m^{-2}$.
2. **What is meant by the sedimentation rate of blood? And how it is used to diagnose some diseases?**
3. **What are the conditions** necessary for a steady flow of a liquid through a tube? Then prove that the velocity of low at a given point inside the tube is inversely

proportional to the cross – sectional area of the tube is inversely proportional to the cross – sectional area of the tube at that point.

4. Show how the viscosity of a liquid affects each of the following. The liquid flow in a tube – the motion of a solid body in the liquid.
5. What is meant by each of the following?
   * Steady (or laminar) flow
   * Streamline
   * Continuity equation
6. What are the factors affecting the frictional force between two layers of a liquid in motion the relation between these factors?
7. What are the applications of viscosity?

Fourth: Problems:

1. A water pipe supplies a house with water. If its radius is 1.5cm and the speed of water flow in it is 0.2 m/s, calculate the speed of water at the end of this pipe where its radius becomes 0.5cm and hence calculate the volume of water flowing in one minute.
2. In the figure shown, the radius of the tube at A=25cm, at D = 15cm, at B=10cm and C=8cm. Calculate the rate of the volume flow at A if water enters the tube at A by a velocity = 2 m/s. Then



   calculate the speed of flow at C and D if the speed of. flow at B = 4 m/s
3. A major artery of diameter 0.5cm is divided into 100 capillaries, the radius of each is 0.1cm, calculate the speed of blood in each capillary knowing that the speed of blood in the major artery is 0.04 m/s.
4. Water flows in a rubber pipe of diameter 1cm with a speed 4 m/s. Find the diameter of the pipe outlet if the water comes out with a speed of 24 m/s.

5. Gasoline flows in a pipe of a diameter 2cm with a velocity 5 m/s. Find the rate of flow and **calculate the time** in minute required to fill a reservoir of volume $20m^2$ with gasoline.
6. Water flows through a tube of diameter 3cm with velocity 2 m/s, **calculate the water volume** flowing in one minute.
7. **Calculate the cross – sectional area** of the opening of a tube that pumps oil with a rate of 18 liter per minute if the velocity of flow is 3 m/s.
8. An oil is pushed with a rate of 6 liter per minute through a pipe attached to another pipe from which the oil goes out with a velocity of 4 m/s. **Calculate the cross – sectional area second pipe.**
9. Water flow in a tube of a cross – sectional area $12cm^2$ with velocity 10m/s **calculate is velocity** at a point at which the cross – sectional area of the tube becomes $4cm^2$.